# EFFECT OF POTASSIUM LEVELS AND WEED CONTROL METHODS ON GROWTH AND YIELD OF MUNGBEAN


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# *CERTIFICATE*

*This is to certify that the thesis entitled* "EFFECT OF POTASSIUM LEVELS AND WEED CONTROL METHODS ON GROWTH AND YIELD 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 (MS)*** *in* ***AGRONOMY****, embodies the results of a piece of bona fide research work carried out by* ***MOHAMMED SHOHRAB HOSSEN BHUIYAN, Registration. No. 11-04389*** *under my supervision and guidance. No part of this thesis has been submitted for any other degree or diploma.*

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

Dated:

Dhaka, Bangladesh

(Professor Dr. Md. Shahidul Islam)
Supervisor

**Dedicated To**

*My Beloved Parents*

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***The Author***

# EFFECT OF POTASSIUM LEVELS AND WEED CONTROL METHODS ON GROWTH AND YIELD OF MUNGBEAN

## ABSTRACT

The experiment was conducted at the research plot of Sher-e-Bangla Agricultural University farm, Dhaka during the period from February, 2017 to June, 2017 to study the effect of potassium levels and weed control methods on the growth and yield of mungbean. The treatment consisted of three potassium level viz. $K_0$= Control (No Potassium), $K_1$ = Recommended dose of potassium (R), $K_2$ = 30% increased of R and four weed control methods viz., $W_0$ = No weeding (control), $W_1$ = One hand weeding at 15 days after sowing (DAS), $W_2$ = Two hand weeding at 15 DAS and 30 DAS, $W_3$ = One paraxon (Paraquat dichloride) spray at 15 DAS. The experiment was laid out in Split plot design with three replications. The seeds of BARI mung-6 variety were the test materials. The highest plant height (16.98, 27.71, 37.92, 43.35 and 45.30 cm at 15, 25, 35, 45 and 55 DAS, respectively), number of branches (4.51, 7.26, 9.48, 10.09 and 10.54 cm at 15, 25, 35, 45, and 55 DAS, respectively), number of leaflets (6.04, 11.90, 14.55, 16.00 and 17.00 at 15, 25, 35, 45, and 55 DAS, respectively) and dry weight plant$^{-1}$ (0.75, 2.50, 5.54, 6.34 and 7.30 at 15, 25, 35, 45, and 55 DAS, respectively) were observed $K_2 \times W_2$ treatment combination. The lowest number and dry weight of Smooth crabgrass (13.68 and 55.50 g), Purple nut sedge (25.37 and 18.77 g), Jungle rice (24.58 and 99.17 g), Bermuda grass (3.03 and 0.10 g), Indian goose grass (0.75 and 5.85 g), Alligator weed (7.49 and 0.74 g), Green amaranth (1.43 and 0.21 g), Common purslane (0.15and 0.08 g) and Spreading dayflower (0.12 and 8.29 g) at harvest were observed in ($K_2 \times W_2$). The highest plant height (27.90), pod length (9.48 cm), seeds pod$^{-1}$ (10.22), weight of 1000 seeds (41.75 g), seed yield (1.63 t ha$^{-1}$), strove yield (2.76 t ha$^{-1}$), biological yield (4.37 t ha$^{-1}$) and harvest Index (37.13%) were observed in the 30% increased of recommended dose of potassium with two hand weeding ($K_2 \times W_2$). The lowest plant height (21.08 cm) was observed in control (No potassium and no weeding) ($K_0 \times W_0$). The results in this study indicated that the plants performed better in respect of seed yield and others yield contributing characters in $K_2 \times W_2$ (30% increased of recommended dose of potassium with two hand weeding) treatment than the control treatment ( $K_0 \times W_{0)}$ . Interaction of $K_2 \times W_2$ (30% increased of recommended dose of potassium with two hand weeding) was found to the most suitable combination for the highest yield of mungbean.

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# Chapter 1
# INTRODUCTION

Ecological degradation from synthetic chemicals, population pressure and poverty coupled with malnutrition are the priorities for the present day agricultural researchers. So the plant scientists are facing the challenge that how to meet the food requirement of this unchecked population (Thirtle *et al.*, 2003). Hence, nutrition oriented sustainable agricultural production system is of utmost priority in the present context. In this acute context, pulses are inseparable ingredients of vegetarian diet and one of the cheapest weapons for combating the malnutrition problem by supplying dietary protein to the people of our country. Pulses are used with meal as delicious food in the poor countries and in the modern world, these are utilized to maintain a good health. Being leguminous, pulse maintain soil fertility by fixing atmospheric nitrogen in available form through symbiosis with rhizobial strains. Pulses are also important component of animal feed and their dried straw is used as hay. In pulses, mungbean (*Vigna radiata* L.) is a vital crop (Khattak *et al.*, 2004). This commonly grown pulse crop belongs to the family Fabaceae. Its edible grain is characterized by good digestibility, flavour, high protein content and absence of any flatulence effects (Ahmad *et al.*, 2008). It also contains amino acid, lysine which is generally deficit in food grains (Elias *et al.*, 1986). It holds the 3$^{rd}$ in respect of protein content, acreage and production and first in market price (BBS, 2014). It is grown three times in a year covering 27530 ha with an average yield of 0.69 t ha$^{-1}$ (BBS, 2015). It is produced for both human consumption and as fodder. Its seed contains 51% carbohydrate, 26% protein, 10% moisture, 4% mineral and 3% vitamin (Afzal *et al.*, 2008). The by-product of mungbean vermicelli processing contains ll-23% crude protein, 0.4-1.8% ether extract, 13-36% crude fibre, 0.30- 0.68 % calcium and 0.17-0.39 % phosphorus depending on the mungbean material (Sitthigripong and Alcantara,1998).

In spite of its importance as food and feed, very little attention has been paid to its quantitative and qualitative improvement in the country. In Bangladesh, total production of pulse is only 0.65 million ton against 2.7 million ton requirement, which accounted for lower yield capacity of the crop (MoA, 2005). As resources are squeezing and population is hiking therefore crop scientists are focusing on improved management practices and advanced crop husbandry techniques (Lipton, 2001). Research on all pulse crops remained neglected until 1980, due to which work on mungbean improvement has not been systematized. Its per hectare yield obtained at farmers field is low, because no systematic efforts have been made in the past to develop a package of technology, which may ensure high seed yield of this crop. Important reasons for low yield of mungbean on farmer's field are the continuous cultivation of traditional low potential cultivars, use of low seed rate and improper agronomic practices (Ansari *et al.*, 2000). Among many other crop production constraints, poor plant spacing and weed management are the most important areas which contribute substantially lower seed yield of mungbean (Ismail and Hall, 2002; Khan *et al.*, 2001).

Weed is one of the most important factors responsible for lower yield of crop (Islam *et al.*, 1989; Rehman and Ullah, 2009). All crops have a vulnerable stage during their life cycle when they are particularly sensitive to weed competition. In general, it ranges up to first 25-50% of the life time of crops. Critical period of weed competition is the range within which a crop must be weeded to save the crop from yield loss (Islam *et al.*, l989). Mungbean is not very competitive against weed and therefore weed control is essential for mungbean production. Seed yield of mungbean was maximum (2108 $kgha^{-1}$) in the weed free treatment (Punia *et al.*, 2004) whereas about 69% reduction in mungbean grain yield due to weeds was estimated by Yadav and Singh (2005).

According to Pandey and Mishra (2003) the decrease in mungbean productivity due to weed competition was 45.6%. Weeds compete with main crop for space, nutrients, water and light, thus crop becomes week result and effect yield lose. It is also recognized that a low weed population can be beneficial to the crop as it provides food and habitat for a range of beneficial organisms (Bueren *et al.*, 2002). Weed crop competition commences with germination of the crop and continues till its maturity. Several growth stages of mungbean such as emergence, flowering and pod setting are greatly hampered by weed. Weed infestation of these stages causes low pod setting and ultimately reduction in yield reduces. Weeds above critical population thresholds can significantly reduce crop yield and quality. However, the aim of weed management should be to maintain weed population at an economic threshold level. Timely control of weeds either manually or using herbicide is essential for higher yield in mungbean. Significantly more seed yields by weeding have been reported in mungbean (Hossain *et al.*, 1990; Kumar and Kiron, 1988; Musa *et al.*, 1996). Herbicides are one of the crucial factors in a worldwide increase in agricultural production. Therefore, herbicides benefit society as a whole. But, use of herbicides has created considerable concern for human health and environment. Fortunately, the health and environmental risks associated with herbicide use are largely a manageable problem.

Various biotic and abiotic fact biotic (e.g., pathogens, insects and weeds) and abiotic (e.g., drought, salinity, cold, frost and waterlogging) factors are responsible for low yields of mungbean (Chotechuen, 1996). During their evolution, plants have developed a wide range of mechanisms to resist a variety of stressed conditions. Increasing evidence suggests that mineral nutrients play a critical role in plant stress resistance (Marschner, 2012, Amtmann *et al.* 2008, Romheld and Kirkby, 2010,Cakmak, 2005, Kant and Kafkafi, 2002). Out of all the mineral nutrients, potassium (K) plays a particularly critical role in plant growth and metabolism, and it contributes greatly to the survival of plants that are under various biotic and abiotic stresses.

The importance of K fertilizer for the formation of crop production and its quality is known. As a consequence, potash consumption has increased dramatically in most regions of the world (Pettigrew, 2008). A strong positive relationship between K fertilizer input and grain yield has been shown (Dong *et al.* 2010). K is essential for many physiological processes, such as photosynthesis, translocation of photosynthates into sink organs, maintenance of turgidity and activation of enzymes under stress conditions (Marschner, 1995; Mengel and Kirkby, 2001). Under low supply of K, chilling or frost induced photo-oxidative damage can be exacerbated causing more decreases in plant growth and yield. Potassium supply in high amounts can provide protection against oxidative damage caused by chilling or frost. A high $K^+$ concentration activated the plant's antioxidant systems which are associated with cold tolerance (Devi *et al*, 2012*)*. Higher K tissue concentrations reduced chilling damage and increased cold resistance, ultimately increasing yield production. Frost damage was inversely related to K concentration and was significantly reduced by K fertilization.

Therefore, the optimum potassium level along with proper weed management could be the most important management for better mungbean production. The present study was therefore, undertaken with the following objectives.

i. To study the effect of potassium levels on the growth, yield attributes and yields of mungbean.
ii. To find out the suitable method of weed control for maximum yield of mungbean.
iii. To study the interaction effect of potassium levels and weed control methods on the growth and yield of mungbean.

# CHAPTER 2

# REVIEW OF LITERATURE

This chapter includes research findings of different researchers in home and abroad regarding the effect of potassium levels on the growth, yield parameters and yields of mungbean and pulse crops. The information have been reviewed and cited under the following headings.

## 2.2. Effect of potassium on the growth and yield of mungbean

Biswash *et al.* (2014) conducted an experiment from February to April, 2013 at the experimental field of the of Sher-e-Bangla Agricultural University Farm to study the effect of potassium fertilizer and vermicompost on growth, yield and nutrient contents of mungbean (BARI Mung 6). The two-factorial experiment was conducted by using RCBD (Randomized Complete Block Design) with three replications. During the experiment, following treatments were included: K0 - 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 $tha^{-1}$. Potassium and vermicompost level 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 11 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 K2O @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 $K_1$ (2O @ 10 kg $ha^{-1}$). Lowest results for above parameters were found from the treatment using no potassium fertilizer ($K_0$). 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 mungbean (*Vigna radiata*) (promising lines VC6172 and Indian), an experiment in the form of split factorial, based on randomized complete block design with three replicates was conducted in 2011, at the research farm of Safi-Abad Dezfool, Iran (latitude 32016' N, longitude 48026' E and altitude 82.9 m above sea level) .Water stress in three levels: irrigation at 120 (no stress), 180 (moderate stress) and 240 (severe stress) mm evaporation from pan, were allocated to the main 12 plots and potassium fertilizer at three levels (0, 90, 180 kg ha$^{-1}$) and two varieties of mungbean (promising line VC6172 and Indian) were allotted to the sub-plots. 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 180 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. They conclude that use of potassium fertilizer can reduce the adverse effects of water stress.

Kumar et al. (2014) conducted to study the effect of different potassium levels on mungbean under custard apple based agri-horti system at Agricultural Research Farm of Rajiv Gandhi South Campus, Barkachha, Mirzapur. The experiment was conducted in a complete randomized block design with seven treatments which were replicated thrice. These treatments were different level of potassium, that is, 0 kg ha$^{-1}$($T_1$), 20 kg ha$^{-1}$ ($T_2$), 40 kg ha$^{-1}$ ($T_3$), 60 kg ha$^{-1}$ ($T_4$), 80 kg ha$^{-1}$ ($T_5$), 100 kg ha$^{-1}$ ($T_6$) and 120 kg ha$^{-1}$ ($T_7$). Potassium application is directly related to growth, plant biomass and yield in crops. Results showed that application of different potassium levels gave varying yield. Lowest yield (700 kg ha$^{-1}$) was obtained with the application of 0 kg ha$^{-1}$and highest yield (1096 kg ha$^{-1}$) was obtained with the application of 120 kg ha$^{-1}$ potassium. It is concluded that the application of 80 kg ha$^{-1}$ potassium gave highest Benefit/Cost ratio of mungbean and looks more remunerative in Vindhyan region.

Hussain *et al.* (2011) carried out an experiment at the area of Department of Agronomy, University of Agriculture, Faisalabad during summer 2005. The objective 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. 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. Genotype M-06 produced higher seed yield than that of NM- 92. 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.

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.

Biswash *et al.* (2014) conducted a field experiment to study the effect of potassium fertilizer and vermin compost on growth, yield and nutrient contents of mungbean (BARI Mung 5). They showed that increasing potassium levels have significant effect on plant height, number of leaves and branches $plant^{-1}$, of seeds $plant^{-1}$, 1000-seed weight, seed yield and stover yield of mungbean, average dry weight $plant^{-1}$, number of pods $plant^{-1}$, number of seeds $pod^{-1}$, number

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.

Hussain *et al.* (2011) conducted an experiment to study the growth and yield response of two cultivars of mungbean (*Vigna radiata* L.) to different potassium levels and showed that the different potassium levels significantly affected the seed yield and yield contributing parameters except number of plants per plot.

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

Tariq *et al.* (2001) reported that the number of pod bearing branches per plant was significantly increased by potassium application in mungbean.

Ali *et al.* (1996) studied the effect of different potassium levels (0, 25, 75,100 and 125 $Kgha^{-1}$) on yield and quality of mungbean and reported that no. of $podsplant^{-1}$, 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.

## 2.2. Effect of weed management

### 2.2.1 Effect on growth characters

#### 2.2.1.1. Plant height

Akter *et al.* (20l3) conducted an experiment at the Agronomy Field of Bangladesh Agricultural University, Mymensingh to assess the effect of weeding on growth, yield and yield contributing characters of mungbean cv. BINA mung- 4 during October 2011 to February 2012.

Three-stage weeding (Emergence-Flowering, Flowering-Pod setting and Pod setting-Maturity) ensured the highest plant height (58.62 cm). Various rates of herbicide (2, 3 and 4 l/ha) including hand weeding were tried for weed control of mungbean at Arid

Zone Research Institute, D.I. Khan, Pakistan by Khan *et al.* (2011) and maximum plant height (67.30 and 59.73 cm) of mungbean was recorded in the treatment of hand weeding. It showed non-significant difference with the lowest rate of pendimethalin 2.0 l $ha^{-1}$, 62.8 and 57.63 cm).

Khaliq *et al*. (2002) investigated the efficacy of different weed management strategies in mungbean and stated that hoeing treatments resulted in reduced weed dry weight by 79% compared to control and maximum plant height while conducting a field trial.

The highest plant height was recorded in the treatment having quizalofop-p-ethyl @ 50 g a.i. $ha^{-1}$ at 21 DAE + HW at 28 DAE. This was similar with treatments receiving quizalofop-pethyl @ 50 g a.i. had at 14 DAE + HW at 21 DAE and quizalofop-p-ethyl @ 50 g a.i. $ha^{-1}$ at 7 DAE + HW at 14 DAE (Kundu *et al.*, 2009).

Chattha *et al.* (2007) conducted a field study at National Agricultural Research Centre (NARC), Islamabad and observed that all the weed control methods significantly affected plant height of mungbean. Among different weed control methods, WC6 (chemical-weeding at 2 - 3 leaf stage of weeds along with hand-weeding at 50 DAS) that was similar to that of WC5 caused a pronounced affect on plant height of mungbean that showed about 5% and 3%, respectively higher plant height as compared to weedy check treatment.

#### 2.2.1.2. **Dry matter weight plant$^{-1}$**

Akter *et al.* (20l3) mentioned that dry weight $plant^{-1}$ (12.38 g) was highest from three stage weeding (Emergence-Flowering, Flowering-Pod setting and Pod setting-Maturity) and the lowest from no weeding treatment while conducting an experiment on mungbean with weed management.

Chattha *et al.* (2007) conducted an experiment in Pakistan and concluded that maximum plant biomass (4.519 t $ha^{-1}$) was produced by chemical-weeding at 2 - 3 leaf stage of weeds along with hand-weeding at 50 DAS. On an average, these treatment caused about 31% increase in plant biomass of mungbean as compared to weedy check treatment.

Kumar *et al.* (2005) conducted a study to evaluate the benefits of the resource conservation technologies in mungbean during kharif 2004 in Haryana, India. Among the weed control treatments, the maximum reduction in dry weight of weeds was recorded in treatment with hand weeding at 20 and 40 DAS.

Anwar *et al.* (2004) investigated the feasibility of sorghum extract as natural weed control in comparison with hand weeding and herbicide. Sorghum extract reduced the weed number and weed weight. It also increased fresh and dry weight of crops.

#### 2.2.1.3. Branches plant$^{-1}$

Akter *et al.* (2013) conducted an experiment at the Agronomy Field Laboratory of Bangladesh Agricultural University, Mymensingh to assess the effect of weeding on growth, yield and yield contributing characters of mungbean (*Vigna radiata* L.) cv. BINA mung- 4 during October 2011 to February 2012. Three-stage weeding (Emergence-Flowering, Flowering-Pod setting and Pod setting-Maturity) ensured the highest plant height (58.62 cm) as well as the highest number of branches (4.45) and leaves (10.34) plant$^{-1}$.

### 2.2.2. Effect on yield contributing characters

#### 2.2.2.1. Pods plant$^{-1}$

A field trial was carried out in Bangladesh by Akter *et al.* (2013) and observed that three-stage weeding (Emergence-Flowering, Flowering-Pod setting and Pod setting-Maturity) ensured the highest number of pods (22.03) plant$^{-1}$.

Khan *et al.* (2011) conducted an experiment in Pakistan on mungbean and stated that among the treatments, hand weeding excelled in number of pods plant$^{-1}$ (16.27 and 12.73) but appeared at par with the lowest rate of pendimathalin (16.00 and 12.20/plant) during the year 2006 and 2007, respectively.

The number of pods plant$^{-1}$, seeds pod$^{-1}$as well as seed yield (1327 kg ha$^{-1}$) were highest in the treatment having quizalofop-p-ethyl @ 50 g a.i. ha$^{-1}$ at 21 DAE + Hand Weeding at 28 DAE. This was closely followed by the treatment with quizalofop-p-ethyl @ 50 g a.i. ha$^{-1}$ at 14 DAE + Hand Weeding at 21 DAE. Similar result was also reported by

Singh *et al.* (2001). The lowest number of pods plant$^{-1}$, seeds pod$^{-1}$ as well as seed yield were recorded in weedy check treatment. It was stated by Kundu *et al*. (2009).

### 2.2.2.2. Pod length (cm)

Awan *et al.* (2009) conducted an experiment on mungbean in Pakistan and pod length was recorded maximum in plots where treatments were terphali (9.9 cm) and hand weeding (9.7 cm); while in plots with 45cm row spacing + tractor and 60cm + tractor, pod length was 9.2 cm and 9.6 cm, respectively compared to control (9.0 cm).

### 2.2.2.3. Seeds pod$^{-1}$

Akter *et al.* (2013) evaluated the performance of weed management and noticed that the longest pod (5.95 cm), the highest number of seeds pod$^{-1}$ were obtained from three-stage weeding (Emergence-Flowering, Flowering-Pod setting and Pod setting-Maturity) in mungbean.

Khan *et al.* (2011) studied an experiment in Pakistan and stated that the highest number of seeds pod$^{-1}$ (12.30) were recorded in hand weeding, which was statistically at par with minimum herbicide rate (2 t ha$^{-1}$) (11.63) during 2006. The said treatment increased the seeds pod$^{-1}$ (10.97) during the year 2007 over control and hand weeding.

Kundu *et al.* (2009) said, that seeds pod$^{-1}$was highest in the treatment having quizalofop-p-ethyl @ 50 g a. i. ha$^{-1}$ at 21 DAE + Hand Weeding at 28 DAE. This was closely followed by the treatment with quizalofop-p-ethyl @ 50 g a. i. ha$^{-1}$ at 14 DAE + Hand Weeding at 21 DAE. Similar result was also reported by Singh *et al.* (2001). The lowest number of pods plant$^{-1}$, seeds pod$^{-1}$ as well as seed yield were recorded in weedy check treatment (Tm).

Chattha *et al*. (2007) concluded that maximum number of seeds pod] of mungbean was obtained with weed control method chemical-weeding at 2 - 3 leaf stage of weeds + hand-weeding at 50 DAS, while rest of the treatments caused similar and significantly better effect than weedy check. They said best weed control method, caused approximately 43% increase in number of seeds pod$^{-1}$ as compared to weedy check treatment this experiment was established in Pakistan.

#### 2.2.2.4.Thousand Seeds weight (g)

The highest values (40.39 and 38.95 g) of 1000-seed weight of mungbean were recorded in hand weeding plots with 17 and 5 percent increase over control during 2006 and 2007, respectively while conducting an field trial in Pakistan by Khan *et al.* (201l).

Awan *et al.* (2009) stated that thousand seed weight of mungbean was increased with reduction in weed dry biomass and found to be maximum (55.0 g) in plots with row spacing 60 cm + tractor followed by 54.67 g in plots with row spacing of 45 cm + tractor.

#### 2.2.2.5. Seed yield

Akter *et al.* (2013) conducted an experiment at the Agronomy Field Laboratory of Bangladesh Agricultural University, Mymensingh to assess the effect of weeding on growth, yield and yield contributing characters of mungbean (*Vigna radiata* L.) cv. BINA mung- 4 during October 2011 to February 2012. The highest seed yield (1.38 t $ha^{-1}$) was obtained from three-stage weeding (Emergence-Flowering, Flowering-Pod setting and Pod setting-Maturity) in mungbean. On the other hand, the lowest seed yield was obtained under no weeding condition. The highest seed yield resulted in higher biological yield (4.70 t $ha^{-1}$) and the highest harvest index (37.15%) in three-stage weeding and the lowest from no weeding.

Mirjha *et al.* (2013) reported that yield attributes and yield of mungbean were significantly increased in weed control treatment over weedy check while a field trial was carried out in India with weed management.

Field experiments were carried out by Ibrahim (2013) in 2010 and 2011 cropping seasons at the Institute for Agricultural Research, Ahmadu Bello University, Zaria-Nigeria to evaluate the effect of pre emergence herbicides on growth and yield parameters of cowpea. There was significant yield increase due to Application of pendimenthaline at 3.5 L hail + Hand weeding of cowpea at 6 WAS (weeks after sowing).

The experiment was conducted by Madukwe *et al.* (2012) during the cropping season of 2011 at the Teaching and Research Farm of the Faculty of Agriculture and Veterinary Medicine, Imo State University to evaluate the most common weed control methods in cowpea. The results showed that chemical weeding at 2-3 leaf stage of the weeds + hand weeding at 50 DAP was more effective in reducing weed biomass than other weed control methods. This superior treatment recorded the highest values of leaf area, plant height, number of branches and number of leaves compared to the other treatments. In addition, number of podsplant$^{-1}$, 100 seed weight and the seed yield were significantly higher.

Khan *et al.* (2011) investigated that hand weeding produced higher yield (1092 and 743.3 kg ha‘1) of mungbean compared to control (631 and 518.8 kg ha$^{-1}$). Herbicide application @ 2 l ha$^{-1}$ also had the highest value/cost ratio (19.3) among the treatments, ranging from 9.6 to 19.3 and might be profitable approach for achieving maximum production of mungbean under rainfed conditions.

Kundu *et al.* (2009) studied an experiment in India and concluded that the seed yield (1327 kg ha'1) ofmungbean was highest in the treatment having quizalofop-p-ethyl @ 50 g a.i. ha'1 at 21 DAE + HW at 28 DAE. This was closely followed by the treatment with quizalofop-p-ethyl @50 g a. i. ha$^{-1}$at l4 DAE + HW at 21 DAE. Similar result was also reported by Singh *et al.* (2001).

The highest weed control efficiency was found in T8 (quizalofop-p-ethyl @ 50 g a.i. had at 21 DAE + HW at 28 DAE) followed by $T_5$ (quizalof0pp- ethyl @ 50 g a.i. ha$^{-1}$ at 14 DAE + HW at 21 DAE). On the other hand the sole chemical treatments like T1 Quizalofop-p-ethyl @ 37.5 g a.i. ha$^{-1}$ at 7 days after emergence (DAE); T4 Quizalofop-p-ethyl @ 50 g a. i. had at 14 DAE and $T_7$ Quizalofop-p-ethyl @ 50 g a. i. ha$^{-1}$ at 21 DAE had lower weed control efficiency in summer mungbean. This result was reported by Kundu *et al*. (2009).

A field experiment was undertaken by Awan *et al.*(2009) in Pakistan and stated that increase in grain yield was 100% where weeds were controlled through tractor using 60 cm row spacing and increase in grain yield was about 85% in case of hand weeding and 45 cm row spacing + tractor compared to control.

Chattha *et al.* (2007) conducted that maximum reduction in density and biomass of the weeds was observed by chemical weeding at 2 - 3 leaf stage of weeds + hand weeding at 50 DAS. There was a significant increase (50%) in grain yield of mungbean due to chemical weeding at 2- 3 leaf stage of weeds + hand weeding at 50 DAS.

Riaz *et al.* (2006) investigated that there was a significant increase (about 58% & 54%) in grain yield of wheat due to chemical weeding at 2 - 3 leaf stage of weeds + hand weeding at 50 DAS (WC6) and two hand weedings after 20 and 40 DAS (WC2), respectively.

Raman (2006) and Chand *et al.* (2003) also observed similar findings of significant reduction in weed count, Weed biomass and highest value of weed control efficiency under two hand weeding at 20 and 40 DAS over herbicides.

Mansoor *et al.* (2004) conducted an experiment in Pakistan during 2003 to investigate the efficacy of various weed management strategies in mungbean (cv. NIAB MUNG 98). Water extracts of sorghum, eucalyptus (*Eucalyptus camaldulensis*) and acacia (*Acacia nilotica*) were used in comparison with hand weeding and a pre-emergence herbicide (Pendimethalin, Stomp 330 EC). The water extract of acacia recorded the highest yield and almost all the yield components followed by the two hand weedings + pre-emergence herbicide treatment.

Among herbicides, tank mixture of fenoxaprop-p-ethyl @ 50 g/ha + chlorimuron-ethyl @ 4.0 gha$^{-1}$ (PoE) consistently increased all the yield attributes viz. podsplant$^{-1}$, pod length and grains pod$^{-1}$ and was statistically at par to 2-HW. The results are in conformity with the findings of Dungarwal *et al.* (2003).

Khajanji *et al*. (2002) obtained higher grain yield with twice hand weeding. Similar result was found by Saikia and Jitendra (1999) and Elliot and Moody (1990).

Weeds compete with main crop for space, nutrients, water and light. It is also recognized that alow weed population can be beneficial to the crop as it provides food and habitat for a range of beneficial organisms said by Bueren *et al.* (2002).

Batish *et al.* (2002) studied to explore the effect of parthenin a sesquiterpene lactone from *Partheniumhy sterophorus* on two weed species viz. *Amaranthus viridis* and *Chenopodium murale*. The study concluded that phytotoxicity of Parthenin could be useful as a natural carbicide for future weed management programmes.

From the review of literatures it may be concluded that potassium fertilization and weed management had significant influence on mungbean and other crops to produce increased plant growth and yield characters.

# Chapter 3
# MATERIALS AND METHODS

The experiment was conducted at the Agronomy field of Sher-e-Bangla Agricultural University, Dhaka, during the period of March 2017 to May 2017 to study the effect of potassium levels and weed control methods on the growth and yield of mungbean. (cv. BARI mung-6). Materials used and methodologies followed in the present investigation have been described in this chapter.

## 3. Description of the experimental site

### 3.1 Location

The field experiment was conducted at the Agronomy field of Sher-e-Bangla Agricultural University, Dhaka during the period from March to June, 2017.

### 3.2 Site and soil

Geographically the experimental field was located at 23° 77′ N latitude and 90° 33' E longitudes at an altitude of 9 m above the mean sea level. The soil belonged to the Agro-ecological Zone - Modhupur Tract (AEZ-28). The land topography was medium high and soil texture was silty clay with pH 6.1. The morphological, physical and chemical characteristics of the experimental soil have been presented in Appendix II.

### 3.3 Climate and weather

The climate of the locality is subtropical which is characterized by high temperature and heavy rainfall during Kharif season (April-September) and scanty rainfall during Rabi season (October-March) associated with moderately low temperature. The mean maximum air temperature and minimum air temperature range were (30.18-31.4600) and (14.85-15.2700) respectively. The mean relative humidity range from (67.82-74.41%), rainfall varies from (4.2-6.3 mm day$^{-1}$), wind speed (1-3 km hr$^{-1}$), sunshine hour (4.15-7.48) and evaporation rate range from (2.04-2.07 mm day$^{-1}$) were recorded from the SAU meteorological station, Dhaka. However the prevailing weather conditions during the study period (March-June) have been presented in Appendix III.

### 3. 4 Plant materials

BARI mung-6 was used as planting material. BARI Mung-6 was developed by Bangladesh Agricultural Research Institute 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 60 days after emergence. It is highly photoinsensetive. One of the main characteristics of this cultivar is synchronization of pod ripening. Average yield of this cultivar is about 1.6-2.0 ton $ha^{-1}$. It contains about 21.2% protein and 46.6% carbohydrate.The seeds of BARI mung-6 for the experiment were collected from BARI, Joydepur, Gazipur. The seeds were dium-shaped, dull and greenish and free from mixture of other seeds, weed seeds and extraneous materials.

### 3. 5 Treatments

The experiment consisted with following two treatment factor:

Factor A: Potassium level - 3

$K_0$= Control (No Potassium)

$K_1$ = Recommended dose of Potassium (R)

$K_2$= 30% increased of R

Factor B: Weed control method - 4

$W_0$ = No weeding (control),

$W_1$ = One hand weeding at 15 days after sowing (DAS)

$W_2$ = Two hand weeding at 15 DAS and 30 DAS,

$W_3$ = One paraxon (paraquat dichloride salt @ 2ml$L^{-1}$) spray at 15 DAS

Treatment combination: Twelve treatment combinations were as follows

i. $K_0 \times W_0$

ii. $K_0 \times W_1$

iii. $K_0 \times W_2$

iv. $K_1 \times W_3$

v. $K_1 \times W_0$

vi. $K_1 \times W_1$

vii. $K_2 \times W_2$

viii. $K_2 \times W_3$

ix. $K_2 \times W_0$

x. $K_3 \times W_1$

xi. $K_3 \times W_2$

xii. $K_3 \times W_3$

**3. 6 Experimental design and layout**

The experiment was laid out in a Split plot design having 3 replications. There were 12treatment combinations and 36 unit plots. The unit plot size was 5.52 $m^2$ (2.4 m X 2.3 m). The blocks and unit plots were separated by 0.75 m and 0.3 m spacing respectively.

**3. 7 Land preparation**

The experimental land was opened with a power tiller on 10 March, 2017. Ploughing and cross ploughing were done with power tiller followed by laddering. Land preparation was completed on 15 March, 2017 and was ready for sowing seeds.

**3. 8 Fertilizer application**

The recommended doses of N, P and K as per BARC (2012) are 20, 17 and 20 kg $ha^{-1}$ Nitrogen and phosphorous were applied as per recommendation and K as per treatment as basal dose.

**3. 9 Sowing of seeds**

Seeds were sown at the rate of 40 kg $ha^{-1}$ in the furrow on 16 March, 2017 and the furrows were covered with the soils soon after seeding. The seed were sown continuously in 30cm apart rows.

**3. 10 Germination of seeds**

Seed germination occurred from 3$^{rd}$ day of sowing. On the 4$^{th}$ day the percentage of germination was more than 85% and on the 5th day nearly all baby plants (seedlings) came out of the soil.

**3. 11 Intercultural operations**

**3. 11. 1 Thinning**

Thinning was done to maintain 10 cm plant to plant distance in each row after 10 days of germination.

### 3. 11. 2 Weed control

Weed control was done as per experimental treatments.

### 3. 11. 3 Irrigation and drainage

Pre-sowing irrigation was given to ensure the maximum germination percentage. During experimental period, there was heavy rainfall for several times. So it was essential to remove the excess water from the field.

## 3. 12 Harvesting and sampling

The crop was harvested at 55 DAS. The crop was harvested plot wise when about 80% of the pods became matured. Samples were collected from different places of each plot leaving undisturbed plant in the center. The plant sample were tied into bundles and carried to the threshing floor. The sample bundles were sun dried by spreading those on the threshing floor. The seeds were separated, cleaned and dried in the sun for 3 to 5 consecutive days for achieving safe moisture of seed.

## 3. 13 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. 14 Drying, cleaning and weighing

The seeds thus collected were dried in the sun for reducing the moisture in the seeds to a safe level. The dried seeds and straw were cleaned and weighed. The sample plants after separating seeds were oven dried at a constant weight for determining dry matter.

## 3. 15 Recording of data

The data were recorded on the following parameters

**A. Crop Growth parameters**

a. Plant height (cm) at 15, 25, 35, 45 and 55 DAS

b. Number of branches plant$^{-1}$at 15, 25, 35, 45 and 55 DAS

c. Number of leaflets plant$^{-1}$at 15, 25, 35, 45 and 55 DAS

d. Dry weight plant$^{-1}$at 15, 25, 35, 45 and 55 DAS

**B. Weed parameters**

a. Weed density (no.)

b. Weed biomass (g)

**C. Yield contributing parameters**

a. Pods plant$^{-1}$ (no.)

b. Pod length (cm)

c. Seeds pod$^{-1}$ (no.)

d. 1000 seeds weight (g)

**D. Yields parameter**

a. Grain yield (t ha$^{-1}$)

b. Stover yield (t ha$^{-1}$)

C. Biological yield (t ha$^{-1}$)

d. Harvest index (%)

**3. 16 Procedure of recording data**

**3. 16. 1 Weed parameters**

**i. Weed density**

The data on weed infestation as well as density were collected from each treated plot at 10 days interval up to harvest. A plant quadrate of 1.0 m$^2$ was placed at three different spots of 5.52 m$^2$ of the plot. The middle quadrate was remained undisturbed for yield data. The infesting species of weeds within the first and third quadrate were identified and their number was counted species wise alternately at different dates.

**ii. Weed biomass**

The weeds inside each quadrate for density count were uprooted, cleaned and separated species wise. The collected weeds were first dried in the sun and then kept in an electrical oven for 72 hours maintaining a constant temperature of 70 °C. After drying, weight of each species was taken and expressed to gm$^{-2}$.

### 3. 16. 2 Crop growth parameter

**i. Plant height (cm)**

Ten plants were collected randomly from each plot. The height of the plants were measured from the ground level to the tip of the plant at 15, 25, 35, 45 days after sowing (DAS) and at harvest time (55 DAS).

**ii. Number of branches plant$^{-1}$**

Ten plants were collected randomly from each plot. Number of fruit bearing branch per plant was counted from each plant sample and then averaged at 15, 25, 35, 45 days after sowing (DAS) and at harvest time (55 DAS).

**iii. Number of leaflets plant$^{-1}$**

Ten plants were collected randomly from each plot. Number of leaves per plant was counted from each plant sample and then averaged at 15, 25, 35, 45 days after sowing (DAS) and at harvest time (55 DAS).

**iv. Dry matter weight plant$^{-1}$ (g)**

Ten plants were collected randomly from each plot at 15, 25, 35, 45 days after sowing (DAS) and at harvest time (55 DAS).The sample plants were oven dried for 72 hours at 70°C and then dry weight plant was determined.

**v. Pods plant$^{-1}$ (no.)**

Number of pods plant$^{-1}$ was counted from the 10 plant sample and then the average pod number was calculated.

**vi. Seeds pod$^{-1}$ (no.)**

Number of seeds pod$^{-1}$ was counted from 10 pods of plants and then the average seed number was calculated.

**vii. Weight of 1000 seeds (g)**

1000-seeds were counted which were taken from the seeds sample of each plot separately, then weighed in an electrical balance and data were recorded.

**viii. Seed yield (t ha$^{-1}$)**

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

**ix. Stover yield (t ha$^{-1}$)**

After separation of seeds from plant, the straw and shell of harvested area was sun dried and the weight was recorded and then converted to t ha$^{-1}$.

**x. 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.

**xi. Harvest index (%)**

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

Economic yield (seed weight)

$$\text{HI (\%)} = \frac{\text{Seed yield}}{\text{Biological yield}} \times 100$$

Here, Biological yield = Grain yield + stover yield

**3. 17 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 at 5% level of significance.

# Chapter 4
# 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 different levels of potassium and methods of weeding and their interaction effects on vegetative growth and yield of mungbean. The growth and yield components such as plant height, leaf number, pod length, and yield of mungbean as influenced by potassium and methods of weeding are presented in Table and Figures. The results of each parameter have been adequately discussed and possible interpretations whenever necessary have been given under the following headlines:

## 4. 1 Plant height

Potassium showed statistically significant variation in respect of plant height when fertilizers in different level were applied (Figure1). However among the different level of potassium fertilizer, $K_2$ (30% increased of recommended dose of Potassium) showed the highest plant height (16.61, 27.60, 36.87, 42.01 and 43.90 cm at 15, 25, 35, 45 and 55 DAS, respectively). The lowest plant height (16.31, 26.00, 34.72, 39.63 and 41.42 cm at 15, 25, 35, 45 and 55 DAS, respectively) was observed in the $K_0$ treatment where no Potassium was applied. This result is similar with the findings of Thesiya *et al.* (2013) who found significant increase in plant height of blackgram due to the application of potassium.

The plant height was significantly influenced by weed management at all growth stages of mungbean (Figure 1). At 15, 25, 35, 45 and 55 DAS, the highest plant height (16.62, 27.63, 37.43, 42.51, and 44.42 cm, respectively) was recorded in $W_2$ (Two hand weedings at 15 DAS and 30 DAS) where the lowest was measured at15, 25, 35, 45 and 55 DAS (16.62, 27.63, 37.43, 42.51, and 44.42 cm, respectively) in $W_0$treatment. Intermediate plant height was obtained from $W_1$ and $W_3$. The result under the present study was in partial agreement with the findings of Chattha *et al.* (2007). Who found that among different weed control methods, chemical-weeding at 2 - 3 leaf stage of Weeds + hand-weeding at 50 DAS gave maximum plant height compared to weedy check treatment.

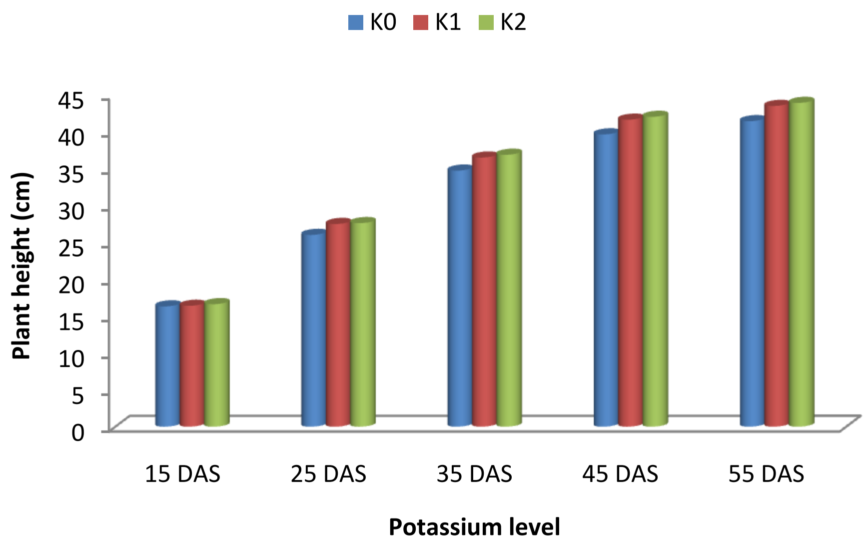



**Figure 1. Effect of potassium level on plant height of mungbean at different days after sowing (DAS) [(LSD $_{(0.05)}$ 1.803, 0.261, 0.369, 0.512 and 0.532 at 15, 25, 35, 45 and 55 DAS, respectively)]**

$K_0$= Control (No Potassium), $K_1$ = Recommended dose of Potassium (R), $K_2$ = 30% increased of Recommended dose of Potassium

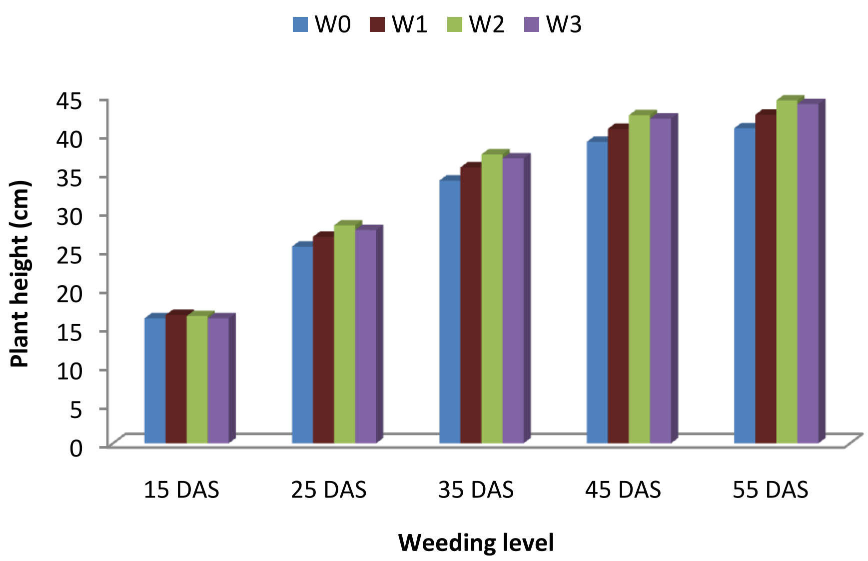



**Figure 2. Effect of weeding level on plant height of mungbean at different days after sowing (DAS) [(LSD $_{(0.05)}$ 2.13,0.327,0.436,0.612 and0.641at 15, 25, 35, 45 and 55 DAS, respectively)]**

$W_0$ = No weeding (control), $W_1$ = One hand weeding at 15 days after sowing (DAS), $W_2$ = Two hand weeding at 15 DAS and 30 DAS, $W_3$ = One paraxon spray at 15 DAS

Interaction effect between different level of potassium and weeding exerted significant effect on plant height except 15 DAS (Table 1). The highest plant height (16.98, 27.71, 37.92, 43.35 and 45.30 cm at 15, 25, 35, 45 and 55 DAS, respectively) was observed in the 30% increased of recommended dose of Potassium with two hand weeding ($K_2 \times W_2$) . The lowest plant height (16.00, 24.03, 32.10, 37.41 and 39.09 cm at 15, 25, 35, 45 and 55 DAS, respectively) was observed control (No Potassium and no weeding) ($K_0 \times W_0$).

**Table 1. Interaction effect of potassium level and weeding on plant height of mungbean at different days after sowing (DAS)**

| Interaction | Plant height (cm) at | | | | |
|---|---|---|---|---|---|
| | 15 DAS | 25 DAS | 35 DAS | 45 DAS | 55 DAS |
| $K_0 \times W_0$ | 16.93 | 24.03h | 32.10g | 37.41h | 39.09h |
| $K_0 \times W_1$ | 16.00 | 25.75g | 34.40f | 39.19g | 40.96g |
| $K_0 \times W_2$ | 16.04 | 27.44d | 36.65c | 41.21c-e | 43.07c-e |
| $K_0 \times W_3$ | 16.62 | 26.75ef | 35.74de | 40.72de | 42.55de |
| $K_1 \times W_0$ | 16.49 | 26.54f | 35.45e | 40.40ef | 42.22ef |
| $K_1 \times W_1$ | 16.89 | 27.20de | 36.33cd | 41.40c-e | 43.26c-e |
| $K_1 \times W_2$ | 16.53 | 28.23bc | 37.70ab | 42.96ab | 44.89ab |
| $K_1 \times W_3$ | 16.66 | 28.43b | 37.98a | 43.27ab | 45.22ab |
| $K_2 \times W_0$ | 16.06 | 25.85g | 34.53f | 39.35fg | 41.12fg |
| $K_2 \times W_1$ | 16.98 | 27.33de | 36.50cd | 41.59cd | 43.47cd |
| $K_2 \times W_2$ | 16.03 | 29.03a | 37.92a | 43.35a | 45.30a |
| $K_2 \times W_3$ | 16.21 | 27.71cd | 37.02bc | 42.18bc | 44.08bc |
| CV (%) | 5.53 | 4.29 | 6.20 | 4.50 | 7.51 |
| $LSD_{(0.05)}$ | 3.691 | 0.566 | 0.755 | 1.055 | 1.11 |
| LS | NS | ** | ** | * | * |

Figures in a column followed by different letter(s) differs significantly whereas figures having common letter(s) do not differ significantly from each other as adjusted by LSD.

CV= Coefficient of variation, LS= Level of significance, $LSD_{(0.05)}$= Least significant difference, NS= Not Significant *= Significant at 5% level of Probability, **= Significant at 1% level of Probability.

$K_0$= Control (No Potassium), $K_1$ = Recommended dose of Potassium (R), $K_2$ = 30% increased of Recommended dose of Potassium, $W_0$ = No weeding (control), $W_1$ = One hand weeding at 15 days after sowing (DAS), $W_2$ = Two hand weeding at 15 DAS and 30 DAS, $W_3$ = One paraxon spray at 15 DAS

### 4. 2 Number of branches Plant$^{-1}$

Application of potassium fertilizer at different level showed significant variation on the number of branches plant$^{-1}$ of mungbean (Figure 3). Among the different fertilizer level $K_2$ (30% increased of recommended dose of Potassium) treatment, showed the highest number of branches plant$^{-1}$ (4.28, 6.90, 36.87, 9.22, 9.81 and 10.25 cm at 15, 25, 35, 45 and 55 DAS, respectively). The lowest number of branches plant$^{-1}$ (4.05, 6.52, 8.70, 9.26 and 9.68 cm at 15, 25, 35, 45 and 55 DAS, respectively) which was closely followed (2.46) by the fertilizer dose of $K_0$. Optimum fertilizer level might be increased the vegetative growth of mungbean that lead to the highest number of branch per plant. Biswash *et al.* (2014) showed that increasing potassium levels have significant effect on number of branches plant$^{-1}$of mungbean.

Branches plant$^{-1}$ was significantly influenced by different weed management at all growth stages of mungbean (Figure 4). At 15, 25, 35, 45 and 55 DAS, the highest number of branches plant$^{-1}$ (4.38, 7.06, 9.36, 9.96 and 10.40 respectively) was recorded in $W_2$ (Two hand weeding at 15 DAS and 30 DAS) and the lowest was achieved with $W_0$ (3.97, 6.39, 8.54, 9.08 and 9.49 respectively). Intermediate number of branches plant$^{-1}$ was obtained from $W_1$ and $W_3$. Muhammad *et al*. (2004) reported that weeding were applied twice, i.e. at 10 and 35 days after sowing significantly affected number of branches plant$^{-1}$.

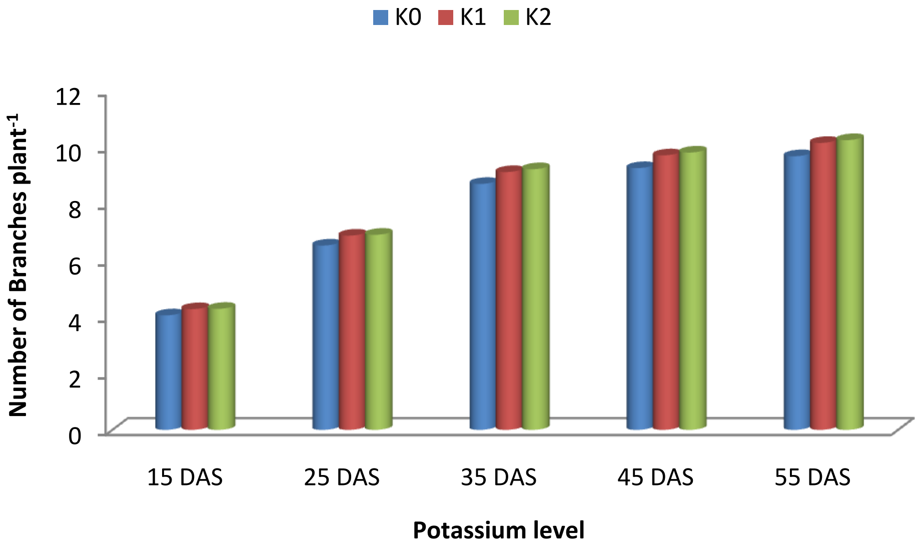



**Figure 3.Effect of potassium level on number of branchesplant$^{-1}$of mungbean at different days after sowing (DAS) [(LSD $_{(0.05)}$ 0.062, 0.020, 0.080, 0.113 and 0.118at 15, 25, 35, 45 and 55 DAS, respectively)].**

$K_0$= Control (No Potassium), $K_1$ = Recommended dose of Potassium (R), $K_2$ = 30% increased of Recommended dose of Potassium

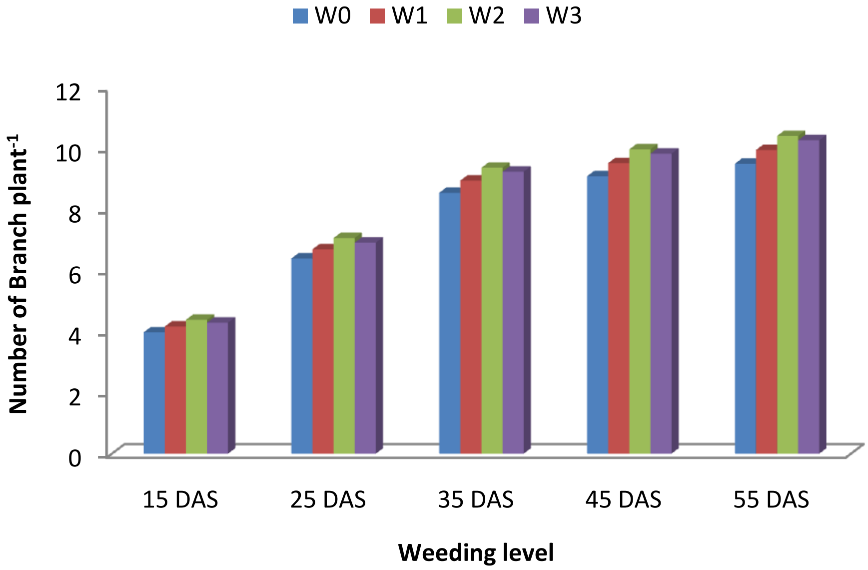



**Figure 4.Effect of weeding level on number of branchesplant$^{-1}$of mungbean at different days after sowing (DAS) [(LSD $_{(0.05)}$ 0.554, 0.093, 0.129, 0.132 and 0.143at 15, 25, 35, 45 and 55 DAS, respectively)].**

$W_0$ = No weeding (control), $W_1$ = One hand weeding at 15 days after sowing (DAS), $W_2$ = Two hand weeding at 15 DAS and 30 DAS, $W_3$ = One paraxon spray at 15 DAS

Interaction effect between different level of potassium and weeding exerted significant effect on number of branch at all DAS (Table 2). The highest plant height (4.51, 7.26,9.48, 10.09 and 10.54 cm at 15, 25, 35, 45, and 55 DAS, respectively) was observed in the 30% increased of recommended dose of Potassium with two hand weeding ($K_2 \times W_2$) at harvest. The lowest plant height (3.77, 6.08, 8.12, 8.64 and 9.02 at 15, 25, 35, 45, and 55 DAS, respectively) was observed control (No Potassium and no weeding) ($K_0 \times W_0$) at 15 DAS and 30 DAS at harvest.

**Table 2. Interaction effect of potassium level and weeding on number of branches plant$^{-1}$of mungbean at different days after sowing (DAS)**

| Interaction | Number of branches plant$^{-1}$at | | | | |
|---|---|---|---|---|---|
| | 15 DAS | 25 DAS | 35 DAS | 45 DAS | 55 DAS |
| $K_0 \times W_0$ | 3.77h | 6.08h | 8.12f | 8.64g | 9.02f |
| $K_0 \times W_1$ | 4.00g | 6.44g | 8.60e | 9.15f | 9.56e |
| $K_0 \times W_2$ | 4.26d | 6.86de | 9.16bc | 9.75cd | 10.19bc |
| $K_0 \times W_3$ | 4.15ef | 6.69 ef | 8.94cd | 9.51de | 9.93cd |
| $K_1 \times W_0$ | 4.12f | 6.64 f | 8.86d | 9.43e | 9.85d |
| $K_1 \times W_1$ | 4.22de | 6.80 d-f | 9.08b-d | 9.66c-e | 10.10b-d |
| $K_1 \times W_2$ | 4.38bc | 7.06bc | 9.43a | 10.03ab | 10.48a |
| $K_1 \times W_3$ | 4.41ab | 7.11ab | 9.49a | 10.10a | 10.56a |
| $K_2 \times W_0$ | 4.01g | 6.46g | 8.63e | 9.19f | 9.60e |
| $K_2 \times W_1$ | 4.24de | 6.83de | 9.13bc | 9.71cd | 10.15bc |
| $K_2 \times W_2$ | 4.51a | 7.26a | 9.48a | 10.09ab | 10.54a |
| $K_2 \times W_3$ | 4.30cd | 6.93cd | 9.25ab | 9.85bc | 10.29ab |
| CV (%) | 4.41 | 3.44 | 7.43 | 6.42 | 5.43 |
| $LSD_{(0.05)}$ | 0.093 | 0.162 | 0.223 | 0.230 | 0.248 |
| LS | ** | * | ** | * | ** |

Figures in a column followed by different letter(s) differs significantly whereas figures having common letter(s) do not differ significantly from each other as adjusted by LSD.

CV= Coefficient of variation, LS= Level of significance, $LSD_{(0.05)}$= Least significant difference, NS= Not Significant *= Significant at 5% level of Probability, **= Significant at 1% level of Probability.

$K_0$= Control (No Potassium), $K_1$ = Recommended dose of Potassium (R), $K_2$ = 30% increased of Recommended dose of Potassium, $W_0$ = No weeding (control), $W_1$ = One hand weeding at 15 days after sowing (DAS), $W_2$ = Two hand weeding at 15 DAS and 30 DAS, $W_3$ = One paraxon spray at 15 DAS

### 4. 3 Number of leaflets Plant$^{-1}$

Significant variation was observed in number of leaflets plant$^{-1}$ of mungbean when different level of potassium were applied (Figure 5). Among the different level, $K_2$ (30% increased of recommended dose of Potassium) treatment, showed the highest number of leaflets plant$^{-1}$ (5.72, 11.31, 13.96, 15.41and 16.41 at 15, 25, 35, 45 and 55 DAS, respectively). On the contrary, the lowest number of leaflets plant$^{-1}$ (5.42, 10.68, 13.33, 14.78 and 15.78 at 15, 25, 35, 45 and 55 DAS, respectively) was observed with $K_0$ (Control= No potassium applied). Biswash *et al.* (2014) showed that increasing potassium levels have significant effect on number of leaves of mungbean.

There was a significant effect on number of leaflets plant$^{-1}$ by weeding at all growth stages of mungbean (Figure 6). At 15, 25, 35, 45, 55 DAS and harvest, the highest number of leaflets plant$^{-1}$ (5.87, 11.57, 14.22, 15.67 and 16.67 respectively) was recorded in $W_2$ (two hand weeding at 15 DAS and 30 DAS) where the lowest was achieved with $W_0$(no weeding) (5.32, 10.48, 13.13, 14.58 and 15.58, respectively). Intermediate number of leaflets plant$^{-1}$ was obtained from $W_1$ and $W_3$ treatment.

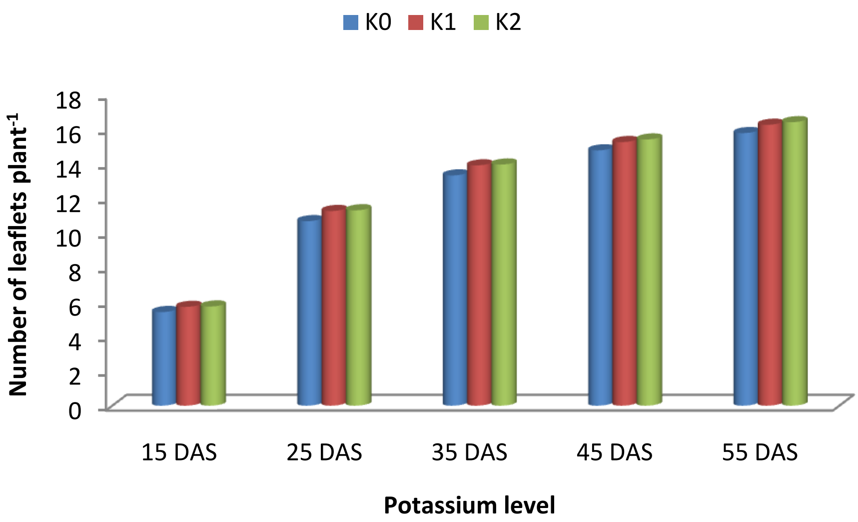



**Figure 5. Effect of potassium level on number of leaflets plant$^{-1}$ of mungbean at different days after sowing (DAS) [(LSD $_{(0.05)}$ 0.062, 0.013, 0.321, 0.045 and 0.342at 15, 25, 35, 45 and 55 DAS, respectively)].**

$K_0$= Control (No Potassium), $K_1$ = Recommended dose of Potassium (R), $K_2$ = 30% increased of Recommended dose of Potassium

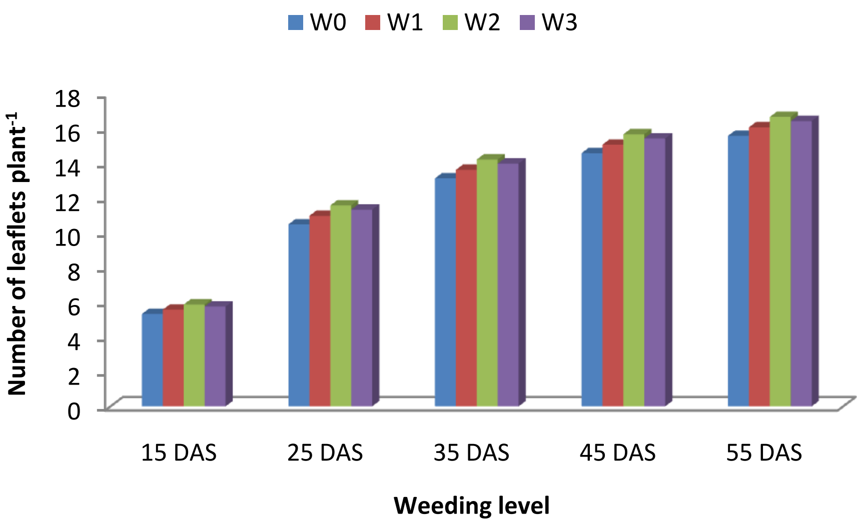



**Figure 6. Effect of weeding level on number of leaflets plant$^{-1}$ of mungbean at different days after sowing (DAS) [LSD $_{(0.05)}$ 20.076, 0.156, 0.143, 0.190 and 0.150at 15, 25, 35, 45 and 55 DAS, respectively].**

$W_0$ = No weeding (control), $W_1$ = One hand weeding at 15 days after sowing (DAS), $W_2$ = Two hand weeding at 15 DAS and 30 DAS, $W_3$ = One paraxon spray at 15 DAS

Interaction effect between different level of potassium and weeding exerted significant effect on number of leaflets plant$^{-1}$ at all DAS (Table 3). The highest number of leaflets plant$^{-1}$(6.04,11.90,14.55, 16.00 and 17.00 at 15, 25, 35, 45, and 55 DAS, respectively) was observed in the 30% increased of recommended dose of Potassium with two hand weeding ($K_2 \times W_2$). The lowest number of leaflets (5.06, 9.96, 12.61, 14.06 and 15.06 cm at 15, 25, 35, 45, and 55 DAS, respectively) was observed control (No Potassium and no weeding) ($K_0 \times W_0$).

**Table 3. Interaction effect of potassium level and weeding on number of leaflets plant$^{-1}$ of mungbean at different days after sowing (DAS)**

| Interaction | Number of leaflets plant$^{-1}$ at | | | | |
|---|---|---|---|---|---|
| | 15 DAS | 25 DAS | 35 DAS | 45 DAS | 55 DAS |
| $K_0 \times W_0$ | 5.06 | 9.96h | 12.61h | 14.06h | 15.06h |
| $K_0 \times W_1$ | 5.36 | 10.56g | 13.21g | 14.66g | 15.66g |
| $K_0 \times W_2$ | 5.71 | 11.25de | 13.90d | 15.35c-e | 16.35de |
| $K_0 \times W_3$ | 5.57 | 10.97ef | 13.62ef | 15.07ef | 16.07ef |
| $K_1 \times W_0$ | 5.52 | 10.88f | 13.53f | 14.98fg | 15.98f |
| $K_1 \times W_1$ | 5.66 | 11.15d-f | 13.80de | 15.25d-f | 16.25de |
| $K_1 \times W_2$ | 5.87 | 11.57bc | 14.22bc | 15.67a-c | 16.67bc |
| $K_1 \times W_3$ | 5.92 | 11.65ab | 14.30ab | 15.75ab | 16.75ab |
| $K_2 \times W_0$ | 5.38 | 10.60g | 13.25g | 14.70g | 15.70g |
| $K_2 \times W_1$ | 5.69 | 11.20de | 13.85de | 15.30d-f | 16.30de |
| $K_2 \times W_2$ | 6.04 | 11.90a | 14.55a | 16.00a | 17.00a |
| $K_2 \times W_3$ | 5.76 | 11.36cd | 14.01cb | 15.46b-d | 16.46cd |
| CV (%) | 6.56 | 5.67 | 6.56 | 3.45 | 7.23 |
| $LSD_{(0.05)}$ | - | 0.271 | 0.248 | 0.330 | 0.260 |
| LS | NS | * | ** | ** | * |

Figures in a column followed by different letter(s) differs significantly whereas figures having common letter(s) do not differ significantly from each other as adjusted by LSD.

CV= Coefficient of variation, LS= Level of significance, $LSD_{(0.05)}$= Least significant difference, NS= Not Significant *= Significant at 5% level of Probability, **= Significant at 1% level of Probability.

$K_0$= Control (No Potassium), $K_1$ = Recommended dose of Potassium (R), $K_2$ = 30% increased of Recommended dose of Potassium, $W_0$ = No weeding (control), $W_1$ = One hand weeding at 15 days after sowing (DAS), $W_2$ = Two hand weeding at 15 DAS and 30 DAS, $W_3$ = One paraxon spray at 15 DAS

## 4. 4 Dry weight plant$^{-1}$

Significant variation was observed in dry weight plant$^{-1}$ of mungbean when different level of potassium were applied (Figure 7). Among the different level, $K_2$ (30% increased of recommended dose of Potassium) treatment, showed the highest dry weight plant$^{-1}$ (0.71, 2.38, 5.36, 6.14 and 7.07 g at 15, 25, 35, 45 and 55 DAS, respectively). On the contrary, the lowest dry weight plant$^{-1}$ (0.68, 2.25, 5.08, 5.81 and 6.70 at 15, 25, 35, 45 and 55 DAS, respectively) was observed with $K_0$ where no potassium was applied.

Above ground dry weight plant$^{-1}$ was significantly influenced by number of weeding at all growth stages of mungbean except 10 DAS (Figure 8). It is remarked from the present study that the increasing time of weeding significantly increased dry weight plant$^{-1}$. At 15, 25, 35, 45 and 55 DAS, the maximum dry weight plant$^{-1}$ (1.13, 3.31, 9.19, 11.69 and 13.37 g, respectively) was recorded in $W_2$ (Two hand weeding at 15 DAS and 30 DAS). The lowest dry weight plant$^{-1}$ was achieved with $W_0$ (5.67, 7.76 and 9.81 g at 40, 50 DAS and harvest, respectively). The result under the present study was in agreement with the findings of Kumar and Kairon (1988) and Malik *et al.* (2000). Kumar and Kairon (1988) found that weed biomass increased and mungbean yield decreased with delay in weeding. They also reported that weed removal at 30 and 40 days after sowing showed high yield.

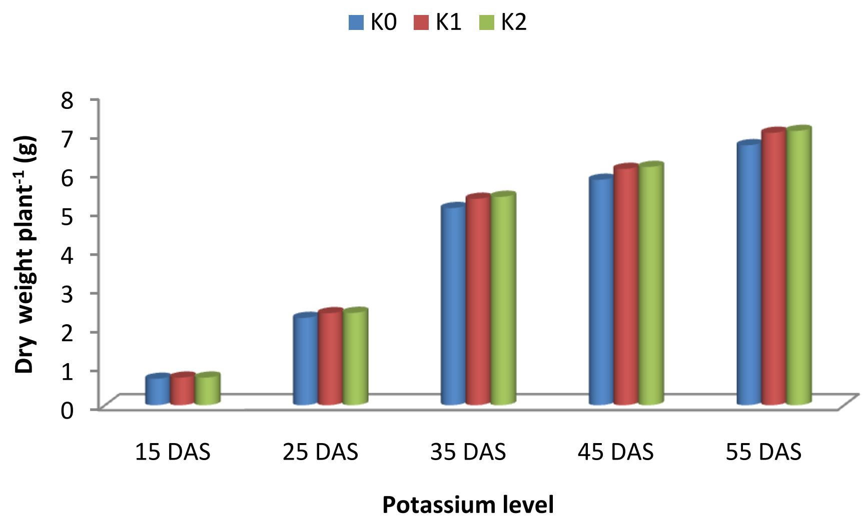



**Figure 7. Effect of potassium level on dry weight plant$^{-1}$of mungbean at different days after sowing [(LSD $_{(0.05)}$-, 0.045, 0.051, 0.62 and0.072 at 15, 25, 35, 45 and 55 DAS, respectively)]**

$K_0$= Control (No Potassium), $K_1$ = Recommended dose of Potassium (R), $K_2$ = 30% increased of Recommended dose of Potassium

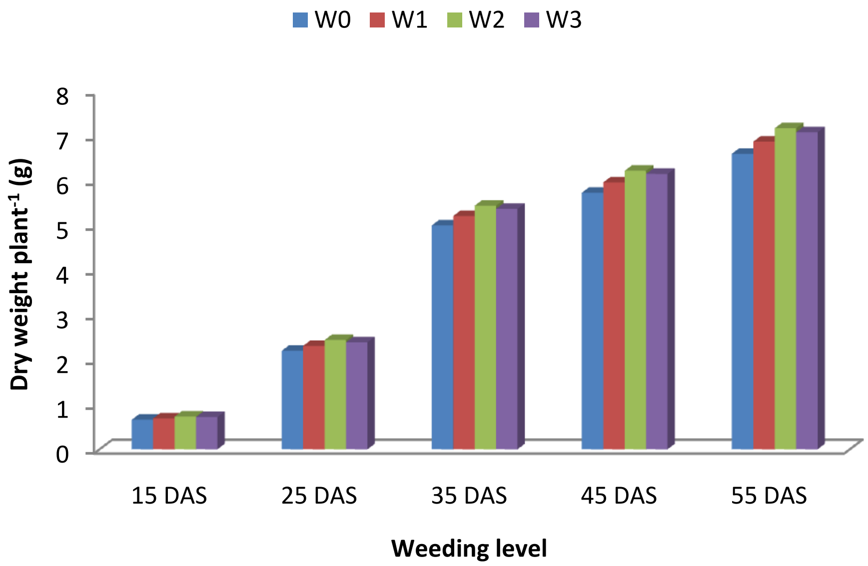



**Figure 8. Effect of weeding level on dry weight plant$^{-1}$ of mungbean at different days after sowing (DAS) [(LSD $_{(0.05)}$-, 0.065, 0.071, 0.082 and 0.088 at 15, 25, 35, 45 and 55 DAS, respectively)]**

$W_0$ = No weeding (control), $W_1$ = One hand weeding at 15 days after sowing (DAS), $W_2$ = Two hand weeding at 15 DAS and 30 DAS, $W_3$ = One paraxon spray at 15 DAS

Interaction effect between different level of potassium and weeding exerted significant effect on dry weight plant$^{-1}$ at all DAS (Table 4). The highest dry weight plant$^{-1}$ (0.75, 2.50, 5.54, 6.34 and 7.30 at 15, 25, 35, 45, and 55 DAS, respectively) was observed in the 30% increased of recommended dose of Potassium with two hand weedings ($K_2 \times W_2$). The lowest dry weight plant$^{-1}$ (0.63, 2.08, 4.80, 5.49 and 6.33 cm at 15, 25, 35, 45, and 55 DAS, respectively) was observed control (No potassium and no weeding) ($K_0 \times W_0$).

**Table 4. Interaction effect of potassium level and weeding on dry weight plant$^{-1}$ of mungbean at different days after sowing (DAS)**

| Interaction | Dry weight plant$^{-1}$ (g) at | | | | |
|---|---|---|---|---|---|
| | 15 DAS | 25 DAS | 35 DAS | 45 DAS | 55 DAS |
| $K_0 \times W_0$ | 0.63 | 2.08g | 4.80g | 5.49g | 6.33g |
| $K_0 \times W_1$ | 0.67 | 2.22f | 5.03f | 5.75f | 6.63f |
| $K_0 \times W_2$ | 0.71 | 2.37c-e | 5.29c-e | 6.05c-e | 6.98c-e |
| $K_0 \times W_3$ | 0.69 | 2.31de | 5.21de | 5.96de | 6.87de |
| $K_1 \times W_0$ | 0.69 | 2.29e | 5.17e | 5.92e | 6.82e |
| $K_1 \times W_1$ | 0.70 | 2.35c-e | 5.29c-e | 6.05c-e | 6.98c-e |
| $K_1 \times W_2$ | 0.73 | 2.44ab | 5.48ab | 6.27ab | 7.22ab |
| $K_1 \times W_3$ | 0.74 | 2.45ab | 5.52a | 6.31ab | 7.27a |
| $K_2 \times W_0$ | 0.67 | 2.23f | 5.05f | 5.77f | 6.66f |
| $K_2 \times W_1$ | 0.71 | 2.36cd | 5.32cd | 6.08cd | 7.01cd |
| $K_2 \times W_2$ | 0.75 | 2.50a | 5.54a | 6.34a | 7.30a |
| $K_2 \times W_3$ | 0.72 | 2.39bc | 5.38bc | 6.16bc | 7.10bc |
| CV (%) | 6.27 | 4.89 | 5.22 | 4.35 | 7.34 |
| $LSD_{(0.05)}$ | - | 0.019 | 0.121 | 0.143 | 0.153 |
| LS | NS | * | ** | ** | * |

Figures in a column followed by different letter(s) differs significantly whereas figures having common letter(s) do not differ significantly from each other as adjusted by LSD.

CV= Coefficient of variation, LS= Level of significance, $LSD_{(0.05)}$= Least significant difference, NS= Not Significant *= Significant at 5% level of Probability, **= Significant at 1% level of Probability.

$K_0$= Control (No Potassium), $K_1$ = Recommended dose of Potassium (R), $K_2$ = 30% increased of Recommended dose of Potassium, $W_0$ = No weeding (control), $W_1$ = One hand weeding at 15 days after sowing (DAS), $W_2$ = Two hand weeding at 15 DAS and 30 DAS, $W_3$ = One paraxon spray at 15 DAS

### 4. 5. Number and dry weight of narrow-leaved weeds

### 4. 5. 1 Smooth carbgrass (*Digitaria ischaemum*)

The effects of different levels of potassium have been shown significant on number and dry weight of smooth crabgrass (Table 5). From the table it was apparent that $K_0$ (where no potash was applied) treatment gave the highest number and dry matter weight (22.57 and 94.35 g). On the contrary, the lowest number and dry weight (17.25 and 71.31 g) was observed with $K_2$ (30% increased of recommended dose of Potassium).

Number and dry weight of smooth crabgrass was significantly influenced by level of weeding (Table 6). It was mentioned from the present study that the increasing number of weeding significantly decreased number and dry weight of smooth crabgrass. The maximum number and weight (24.93 and 103.55 g) was recorded in $W_0$ and the minimum number and weight (17.29 and 72.17 g) was achieved by $W_2$ (Two hand weedings at 15 DAS and 30 DAS) treatment. The results from $W_1$ and $W_2$ on number and weight were intermediate compared to highest and lowest number and weight of smooth crabgrass.

Interaction effect between different levels of potassium and weeding exerted significant effects on number and weight of crabgrass at all DAS (Table 7). The highest number and dry weight of crabgrass (27.35 and 113.60 g) at harvest was observed control (No Potassium and no weeding) ($K_0 \times W_0$). The lowest number and dry weight of smooth crabgrass (13.68 and 55.50 g) at harvest was observed in the 30% increased of recommended dose of Potassium with two hand weeding ($K_2 \times W_2$).

**Table 5. Effect of potassium on number and dry weight of narrow leaves weed in mungbean field at harvest**

| Potassium level | Smooth crabgrass (*Digitaria ischaemum*) | | Purple nutsedge (*Cyperus rotundus*) | | Jungle rice (*Echinochola colonum*) | | Bermuda grass (*Cynodon dactylon*) | | Indian goose grass (*Eleusine indica*) | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Number $m^{-2}$ | Weight (g $m^{-2}$) | Number $m^{-2}$ | Weight (g $m^{-2}$) | Number $m^{-2}$ | Weight (g $m^{-2}$) | Number $m^{-2}$ | Weight (g $m^{-2}$) | Number $m^{-2}$ | Weight (g $m^{-2}$) |
| $K_0$ | 22.57a | 94.35a | 42.00a | 31.08a | 43.26a | 164.60a | 5.16a | 0.16a | 1.24a | 9.81a |
| $K_1$ | 20.92b | 86.89b | 38.78b | 28.70b | 39.77b | 151.89b | 4.77b | 0.14a | 1.14b | 9.03b |
| $K_2$ | 17.25c | 71.31c | 31.98c | 23.67c | 32.65c | 125.26c | 3.93c | 0.12b | 0.94c | 7.45c |
| CV (%) | 4.12 | 4.38 | 4.79 | 4.89 | 4.28 | 3.80 | 5.12 | 3.32 | 4.12 | 4.87 |
| $LSD_{(0.05)}$ | 0.850 | 1.87 | 0.376 | 1.041 | 1.039 | 3.793 | 0.251 | 0.011 | 0.05 | 0.277 |
| LS | ** | ** | ** | * | ** | ** | ** | * | ** | ** |

Figures in a column followed by different letter(s) differs significantly whereas figures having common letter(s) do not differ significantly from each other as adjusted by LSD.

CV= Coefficient of variation, LS= Level of significance, $LSD_{(0.05)}$= Least significant difference, *= Significant at 5% level of Probability, **= Significant at 1% level of Probability.

$K_0$= Control (No Potassium), $K_1$ = Recommended dose of Potassium (R), $K_2$ = 30% increased of Recommended dose of Potassium

**Table 6. Effect of weeding on number and dry weight of narrow leaved weed in mungbean field at harvest**

| Potassium level | Smooth crabgrass (*Digitaria ischaemum*) | | Purple nutsedge (*Cyperus rotundus*) | | Jungle rice (*Echinochola colonum*) | | Bermuda grass (*Cynodon dactylon*) | | Indian goose grass (*Eleusine indica*) | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Number $m^{-2}$ | Weight (g $m^{-2}$) | Number $m^{-2}$ | Weight (g $m^{-2}$) | Number $m^{-2}$ | Weight (g $m^{-2}$) | Number $m^{-2}$ | Weight (g $m^{-2}$) | Number $m^{-2}$ | Weight (g $m^{-2}$) |
| $W_0$ | 24.93a | 103.55a | 46.22a | 34.20a | 47.79a | 181.13a | 5.72a | 0.17a | 1.36a | 10.79a |
| $W_1$ | 20.39b | 84.71b | 37.81b | 27.98b | 39.09b | 148.16b | 4.68b | 0.14b | 1.11b | 8.83b |
| $W_2$ | 17.29d | 72.17d | 32.26d | 23.88d | 32.14d | 126.25d | 3.87d | 0.12c | 0.95d | 7.48d |
| $W_3$ | 18.37c | 76.31c | 34.06c | 25.20c | 35.22c | 133.47c | 4.22c | 0.13c | 1.00c | 7.95c |
| CV (%) | 4.99 | 3.98 | 5.98 | 5.99 | 5.19 | 3.91 | 5.02 | 4.00 | 4.33 | 4.93 |
| $LSD_{(0.05)}$ | 0.641 | 2.719 | 1.275 | 0.94 | 1.336 | 4.703 | 0.144 | 0.009 | 0.044 | 0.288 |
| LS | ** | ** | ** | ** | ** | ** | ** | * | ** | ** |

Figures in a column followed by different letter(s) differs significantly whereas figures having common letter(s) do not differ significantly from each other as adjusted by LSD.

CV= Coefficient of variation, LS= Level of significance, $LSD_{(0.05)}$= Least significant difference, NS= Not Significant *= Significant at 5% level of Probability, **= Significant at 1% level of Probability.

$W_0$ = No weeding (control), $W_1$ = One hand weeding at 15 days after sowing (DAS), $W_2$ = Two hand weeding at 15 DAS and 30 DAS, $W_3$ = One paraxon spray at 15 DAS

**Table 7. Interaction effect of potassium and weeding on number and dry weight of narrow leaved weed in mungbean field at harvest**

| Interaction effect | Smooth carbgrass (*Digitaria ischaemum*) | | Purple nutsedge (*Cyperus rotundus*) | | Jungle rice (*Echinochola colonum*) | | Bermuda grass (*Cynodon dactylon*) | | Indian goose grass (*Eleusine indica*) | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Number $m^{-2}$ | Weight ($g\ m^{-2}$) | Number $m^{-2}$ | Weight ($g\ m^{-2}$) | Number $m^{-2}$ | Weight ($g\ m^{-2}$) | Number $m^{-2}$ | Weight ($g\ m^{-2}$) | Number $m^{-2}$ | Weight ($g\ m^{-2}$) |
| $K_0 \times W_0$ | 27.35a | 113.60a | 50.71a | 37.52a | 52.43a | 198.71a | 6.27a | 0.18a | 1.49a | 11.84a |
| $K_0 \times W_1$ | 22.42c | 93.13c | 41.57c | 30.76c | 42.98c | 162.89c | 5.14c | 0.16b | 1.22c | 9.71c |
| $K_0 \times W_2$ | 19.70de | 84.21de | 37.14de | 27.48de | 37.74de | 145.56de | 4.43e | 0.14c-e | 1.10ef | 8.67de |
| $K_0 \times W_3$ | 20.82d | 86.48d | 38.60d | 28.56d | 39.91d | 151.26d | 4.78d | 0.14b-e | 1.14de | 9.01d |
| $K_1 \times W_0$ | 25.33b | 105.21b | 46.96b | 34.75b | 48.56b | 184.02b | 5.81b | 0.18a | 1.38b | 10.97b |
| $K_1 \times W_1$ | 20.69d | 85.96d | 38.37d | 28.39d | 39.67d | 150.35d | 4.75d | 0.15b-d | 1.13de | 8.96d |
| $K_1 \times W_2$ | 18.49f | 76.81f | 34.28f | 25.37f | 34.12g | 134.01f | 4.14fg | 0.13e | 1.01g | 7.90f |
| $K_1 \times W_3$ | 19.16ef | 79.58ef | 35.52ef | 26.28ef | 36.72ef | 139.19ef | 4.40ef | 0.13de | 1.04fg | 8.29ef |
| $K_2 \times W_0$ | 22.11c | 91.85c | 41.00c | 30.34c | 42.39c | 160.65c | 5.07c | 0.15bc | 1.21cd | 9.57c |
| $K_2 \times W_1$ | 18.07f | 75.04f | 33.50f | 24.79f | 34.63fg | 131.25f | 4.14g | 0.13e | 0.99g | 7.82f |
| $K_2 \times W_2$ | 13.68h | 55.50h | 25.37h | 18.77h | 24.58i | 99.17h | 3.03i | 0.10f | 0.75i | 5.85h |
| $K_2 \times W_3$ | 15.13g | 62.87g | 28.06g | 20.76g | 29.01h | 109.96g | 3.47h | 0.10f | 0.83h | 6.55g |
| CV (%) | 4.99 | 3.98 | 5.98 | 5.99 | 5.19 | 3.91 | 5.02 | 4.00 | 4.33 | 4.93 |
| $LSD_{(0.05)}$ | 1.10 | 4.709 | 2.209 | 1.643 | 2.314 | 8.146 | 0.2486 | 0.017 | 0.076 | 0.500 |
| LS | ** | ** | ** | * | * | NS | NS | * | * | NS |

Figures in a column followed by different letter(s) differs significantly whereas figures having common letter(s) do not differ significantly from each other as adjusted by LDS.

CV= Coefficient of variation, LS= Level of significance, $LSD_{(0.05)}$= Least significant difference, NS= Not Significant *= Significant at 5% level of Probability, **= Significant at 1% level of Probability.

$K_0$= Control (No Potassium), $K_1$ = Recommended dose of Potassium (R), $K_2$ = 30% increased of Recommended dose of Potassium, $W_0$ = No weeding (control), $W_1$ = One hand weeding at 15 days after sowing (DAS), $W_2$ = Two hand weeding at 15 DAS and 30 DAS, $W_3$ = One paraxon spray at 15 DAS

### 4. 5. 2 Purple nutsedge (*Cyperus rotundus*)

The effects of different levels of potassium were found significant on number and dry weight of Purple nutsedge (Table 5). It was apparent that $K_0$ (where no potash was applied) treatment gave the highest number and dry weight (42.00 and 31.08 g). On the contrary, the lowest number and weight (31.98 and 23.67 g) was observed with $K_2$ (30% increased of recommended dose of Potassium) treatment.

Number and dry weight of Purple nutsedge was also significantly influenced by weeding (Table 6). The increasing number of weeding significantly decreased number and weight of weeding. The highest number and weight (34.20 and 47.79 g) was found from $W_0$. On the contrary, the lowest number and weight (32.26 and 23.88 g) was observed with $W_2$ (Two hand weeding at 15 DAS and 30 DAS).

Interaction effect between different level of potassium and weeding exerted significant effect on number and weight of Purple nutsedge at harvest (Table 7). The highest number and weight of Purple nutsedge (50.71 and 37.52 g) at harvest was observed control (No potassium and no weeding) ($K_0 \times W_0$). The lowest dry number and weight of Purple nutsedge (25.37 and 18.77 g) at harvest was observed in the 30% increased of recommended dose of Potassium with two hand weeding ($K_2 \times W_2$).

### 4. 5. 3 Jungle rice (*Echinochola colonum*)

The effects of different levels of potassium have been shown significant on number and weight of Jungle rice(Table 5). From the table it was apparent that $K_0$ (where no potash was applied) treatment gave the highest number and weight (43.26 and 164.60 g). On the contrary, the lowest number and weight (32.65 and 125.26 g) was observed with $K_2$ (30% increased of recommended dose of Potassium) treatment.

Number and dry weight of jungle rice was significantly influenced by level of weeding (Table 6). It is mentioned from the present study that the increasing number of weeding significantly decreased number and weight of weeding. The highest number and weight (47.79 and 181.13 g) was found from $W_0$. On the contrary, the lowest number and weight (32.14 and 126.25 g) was observed with $W_2$ (two hand weeding at 15 DAS and 30 DAS).

Interaction effect between different level of potassium and weeding exerted significant effect on number and weight of jungle rice at harvest (Table 7). The highest number and weight of jungle rice (52.43 and 198.71 g) at harvest was observed control (No Potassium and no weeding) ($K_0 \times W_0$). The lowest dry number and weight of jungle rice (24.58 and 99.17 g) at harvest was observed in the 30% increased of recommended dose of Potassium with two hand weeding ($K_2 \times W_2$).

**4.5.4 Bermuda grass (*Cynodon dactylon*)**

Different level of potassium showed significant variations in respect of number and weight of Bermuda grass (Table 5). Among the different level of K fertilizers, $K_0$ (where no potash was applied) showed the highest number and weight (26.84 and 111.50 g). On the contrary, the lowest number and weight (26.84 and 111.50 g) was observed with $K_2$ (30% increased of recommended dose of Potassium) treatment.

Number and weight of Bermuda grass was significantly influenced by level of weeding (Table 6). It was found that the increasing number of weeding significantly decreased number and weight of Bermuda grass. The maximum number and weight (5.72 and 0.17 g) was recorded in $W_0$and the minimum number and weight (3.87 and 0.13 g) was achieved by $W_2$ (Two hand weeding at 15 DAS and 30 DAS). The results from $W_1$ and $W_2$ on number and weight were intermediate compared to highest and lowest biological yield.

Interaction effect between different level of potassium and weeding exerted significant effect on number and weight of Bermuda grass at harvest (Table 7). The highest number and weight of Bermuda grass (6.27 and 0.18 g) at harvest was observed control (No Potassium and no weeding) ($K_0 \times W_0$). The lowest dry number and weight of Bermuda grass(3.03 and 0.10 g) at harvest was observed in the 30% increased of recommended dose of Potassium with two hand weeding ($K_2 \times W_2$).

**4.5.5 Indian goose grass (*Eleusine indica*)**

The effects of different levels of potassium have been shown significant on number and weight of Indian goose grass at harvest (Table 5). From the table it was apparent that $K_0$ (where no potash was applied) treatment gave the highest number and weight (1.24and

9.81 g). On the contrary, the lowest number and weight (0.94 and 7.45 g) was observed with $K_2$ (30% increased of recommended dose of Potassium).

Number and weight of Indian goose grass was significantly influenced by level of weeding (Table 6). Result showed that the increasing number of weeding significantly decreased number and weight of Indian goose grass. The highest number and weight of Indian goose grass (1.36 and 10.79 g) was recorded in $W_2$ and the lowest was achieved by $W_0$ (0.95 and 7.48 g).

Interaction effect between different level of potassium and weeding exerted significant effect on number and weight of Indian goose grass at harvest (Table 7). The highest number and weight of Indian goose grass (1.49 and 11.84 g) at harvest was observed control (No potassium and no weeding) ($K_0 \times W_0$). The lowest dry number and weight of Indian goose grass(0.75 and 5.85 g) at harvest was observed in the 30% increased of recommended dose of Potassium with two hand weeding ($K_2 \times W_2$).

## 4.6 Number and dry weight of broad-leaved weeds

### 4.6.1 Alligator weed (*Alternanthera philoxeroides*)

Different level of potassium showed significant variations in respect of number and weight of Alligator weed (Table 8). $K_0$ (No potassium) showed the highest number and weight (12.41 and 1.20 g). On the contrary, the lowest number and weight (9.45 and 0.91 g) was observed with $K_2$ (30% increased of recommended dose of Potassium) treatment.

Number and weight of Alligator weed was significantly influenced by level of weeding (Table 9). It was observed that the increasing number of weeding significantly decreased number and weight of Alligator weed. The highest number and weight (13.65 and 1.32 g)was recorded in $W_0$ and the lowest number and weight was achieved by $W_2$ (Two hand weeding at 15 DAS and 30 DAS) (9.53 and 0.92 g)

Interaction effect between different level of potassium and weeding exerted significant effect on number and weight of Alligator weed at harvest (Table 10). The highest number and weight of Alligator weed (14.98and 1.44 g) at harvest was observed control (No Potassium and no weeding) ($K_0 \times W_0$). The lowest dry number and weight of Alligator weed (7.49 and 0.74 g) at harvest was observed in the 30% increased of recommended dose of Potassium with two hand weeding ($K_2 \times W_2$).

**Table 8. Effect of potassium level on number and dry weight of broad leaves weed in mungbean field at harvest**

| Potassium level | Alligator weed (*Alternanthera philoxeroides*) | | Green amaranth (*Amaranthus viridis*) | | Common purslane (*Purtulaca oleracea*) | | Spreading dayflower (*Cyanotis axillaris*) | |
|---|---|---|---|---|---|---|---|---|
| | Number ($m^{-2}$) | Weight ($g\ m^{-2}$) | Number ($m^{-2}$) | Weight ($g\ m^{-2}$) | Number ($m^{-2}$) | Weight ($g\ m^{-2}$) | Number ($m^{-2}$) | Weight ($g\ m^{-2}$) |
| $K_0$ | 12.41a | 1.20a | 2.36a | 0.35a | 0.24a | 0.13a | 0.18a | 12.41a |
| $K_1$ | 11.45b | 1.11b | 2.18b | 0.32b | 0.22b | 0.12b | 0.16b | 11.37b |
| $K_2$ | 9.45c | 0.91c | 1.80c | 0.27c | 0.18c | 0.10c | 0.13c | 9.38c |
| CV (%) | 4.07 | 7.19 | 4.31 | 4.02 | 4.15 | 6.15 | 5.29 | 6.03 |
| $LSD_{(0.05)}$ | 0.433 | 0.354 | 0.873 | 0.016 | 0.013 | 0.011 | 0.011 | 0.446 |
| LS | ** | * | ** | ** | * | * | * | ** |

Figures in a column followed by different letter(s) differs significantly whereas figures having common letter(s) do not differ significantly from each other as adjusted by LSD. CV= Coefficient of variation, LS= Level of significance, $LSD_{(0.05)}$= Least significant difference, *= Significant at 5% level of Probability, **= Significant at 1% level of Probability.

$K_0$= Control (No Potassium), $K_1$ = Recommended dose of Potassium (R), $K_2$ = 30% increased of Recommended dose of Potassium

**Table 9. Effect of weeding level on number and dry weight of broad leaved weed in mungbean field at harvest**

| Weeding level | Alligator weed (*Alternanthera philoxeroides*) | | Green amaranth (*Amaranthus viridis*) | | Common purslane (*Purtulaca oleracea*) | | Spreading dayflower (*Cyanotis axillaris*) | |
|---|---|---|---|---|---|---|---|---|
| | Number ($m^{-2}$) | Weight ($g\ m^{-2}$) | Number ($m^{-2}$) | Weight ($g\ m^{-2}$) | Number ($m^{-2}$) | Weight ($g\ m^{-2}$) | Number ($m^{-2}$) | Weight ($g\ m^{-2}$) |
| $W_0$ | 13.65 | 1.32 | 2.60 | 0.39a | 0.26a | 0.14a | 0.19a | 13.65a |
| $W_1$ | 11.17 | 1.07 | 2.13 | 0.32b | 0.21b | 0.11b | 0.16b | 11.17b |
| $W_2$ | 9.53 | 0.92 | 1.82 | 0.27c | 0.18c | 0.10c | 0.14c | 9.34d |
| $W_3$ | 10.06 | 0.97 | 1.92 | 0.29bc | 0.19c | 0.11bc | 0.14c | 10.06c |
| CV (%) | 3.98 | 8.77 | 4.46 | 4.34 | 4.35 | 5.16 | 4.65 | 7.03 |
| $LSD_{(0.05)}$ | 0.381 | 0.313 | 0.071 | 0.044 | 0.012 | 0.009 | 0.008 | 0.408 |
| LS | ** | ** | ** | ** | ** | ** | ** | ** |

Figures in a column followed by different letter(s) differs significantly whereas figures having common letter(s) do not differ significantly from each other as adjusted by LSD. CV= Coefficient of variation, LS= Level of significance, $LSD_{(0.05)}$= Least significant difference, *= Significant at 5% level of Probability, **= Significant at 1% level of Probability.

$W_0$ = No weeding (control), $W_1$ = One hand weeding at 15 days after sowing (DAS), $W_2$ = Two hand weeding at 15 DAS and 30 DAS, $W_3$ = One paraxon spray at 15 DAS

**Table10. Interaction effect of potassium and weeding on number and dry weight of broad leaved weed in mungbean yield at harvest**

| Interaction | Alligator weed (*Alternanthera philoxeroides*) | | Green amaranth (*Amaranthus viridis*) | | Common purslane (*Purtulaca oleracea*) | | Spreading dayflower (*Cyanotis axillaris*) | |
|---|---|---|---|---|---|---|---|---|
| | Number ($m^{-2}$) | Weight ($g\ m^{-2}$) | Number ($m^{-2}$) | Weight ($g\ m^{-2}$) | Number ($m^{-2}$) | Weight ($g\ m^{-2}$) | Number ($m^{-2}$) | Weight ($g\ m^{-2}$) |
| $K_0 \times W_0$ | 14.98a | 1.44a | 2.85a | 0.43a | 0.28 | 0.15 | 0.21 | 14.98a |
| $K_0 \times W_1$ | 12.28c | 1.18c | 2.34c | 0.35a-c | 0.24 | 0.13 | 0.18 | 12.28c |
| $K_0 \times W_2$ | 10.97de | 1.06de | 2.09de | 0.31b-d | 0.21 | 0.13 | 0.16 | 10.97ef |
| $K_0 \times W_3$ | 11.40d | 1.10d | 2.17d | 0.32bc | 0.22 | 0.12 | 0.16 | 11.40de |
| $K_1 \times W_0$ | 13.87b | 1.34b | 2.64b | 0.39ab | 0.27 | 0.14 | 0.20 | 13.87b |
| $K_1 \times W_1$ | 11.33d | 1.09d | 2.16d | 0.32bc | 0.22 | 0.12 | 0.16 | 11.33de |
| $K_1 \times W_2$ | 10.12f | 0.98fg | 1.93f | 0.28c-e | 0.19 | 0.11 | 0.15 | 9.79g |
| $K_1 \times W_3$ | 10.49e | 1.01ef | 2.00ef | 0.30cd | 0.20 | 0.11 | 0.15 | 10.49fg |
| $K_2 \times W_0$ | 12.11c | 1.17c | 2.30c | 0.34bc | 0.23 | 0.12 | 0.17 | 12.11cd |
| $K_2 \times W_1$ | 9.89f | 0.95g | 1.89f | 0.28c-e | 0.19 | 0.10 | 0.14 | 9.89g |
| $K_2 \times W_2$ | 7.49h | 0.74i | 1.43h | 0.21e | 0.15 | 0.08 | 0.11 | 7.25i |
| $K_2 \times W_3$ | 8.29g | 0.80h | 1.58g | 0.23de | 0.16 | 0.09 | 0.12 | 8.29h |
| CV (%) | 3.98 | 8.77 | 4.46 | 4.34 | 4.35 | 5.16 | 4.65 | 7.03 |
| $LSD_{(0.05)}$ | 0.659 | 0.054 | 0.121 | 0.076 | - | - | - | 0.767 |
| LS | ** | * | * | NS | NS | NS | NS | ** |

Figures in a column followed by different letter(s) differs significantly whereas figures having common letter(s) do not differ significantly from each other as adjusted by LSD. CV= Coefficient of variation, LS= Level of significance, $LSD_{(0.05)}$= Least significant difference, NS= Not Significant *= Significant at 5% level of Probability, **= Significant at 1% level of Probability.

$K_0$= Control (No Potassium), $K_1$ = Recommended dose of Potassium (R), $K_2$ = 30% increased of Recommended dose of Potassium, $W_0$ = No weeding (control), $W_1$ = One hand weeding at 15 days after sowing (DAS), $W_2$ = Two hand weeding at 15 DAS and 30 DAS, $W_3$ = One paraxon spray at 15 DAS

### 4.6.2 Green amaranth (*Amaranthus viridis*)

The effects of different levels of potassium have been shown significant on number and weight of Green amaranth (Table 8). From the table it was apparent that $K_0$ (where no potash was applied) treatment gave the highest number and weight (2.36 and 0.35 g). On the contrary, the lowest number and weight (1.80 and 0.27 g) was observed with $K_2$ (30% increased of recommended dose of Potassium).

Weeding management had significantly influenced on number and weight of Green amaranth (Table 9). The maximum number and weight (2.60 and 0.39 g) was recorded in $W_0$ and the munimum number and weight (1.82 and 0.27 g) was achieved by $W_2$ (two hand weeding at 15 DAS and 30 DAS). The results from $W_1$ and $W_2$ on Green amaranth were intermediate compared to highest and lowest Green amaranth.

Interaction effect between different level of potassium and weeding exerted significant effect on number and weight of Green amaranth at harvest (Table 10). The highest number and weight of Green amaranth (2.85 and 0.43 g) at harvest was observed control (No Potassium and no weeding) ($K_0 \times W_0$). The lowest dry number and weight of Green amaranth (1.43 and 0.21 g) at harvest was observed in the 30% increased of recommended dose of Potassium with two hand weeding ($K_2 \times W_2$).

### 4.6.3 Common purslane (*Purtulaca oleracea*)

The effects of different levels of potassium have been shown significant on number and weight of common purslane (Table 8). From the table it was apparent that $K_0$ (where no potash was applied) treatment gave the highest number and weight (0.24 and 0.13 g). On the contrary, the lowest number and weight (0.18 and 0.10 g) was observed with $K_2$ (30% increased of recommended dose of Potassium).

Number and weight of Common purslane was significantly influenced by level of weeding (Table 9). The highest number and weight (0.26 and 0.14 g) was recorded in $W_3$ and the lowest number and weight (0.19 and 0.11 g) was achieved by $W_2$ (Two hand weeding at 15 DAS and 30 DAS).

Interaction effect between different level of potassium and weeding observed non significant effect on number and weight of common purslane at harvest (Table 10). The highest number and weight of common purslane (0.28 and 0.15 g) at harvest was observed control (No Potassium and no weeding) ($K_0 \times W_0$). The lowest dry number and weight of common purslane (0.15and 0.08 g) at harvest was observed in the 30% increased of recommended dose of Potassium with two hand weeding ($K_2 \times W_2$).

### 4.6.4 Spreading dayflower (*Cyanotis axillaris*)

Different level of potassium showed significant variations in respect of number and weight of Spreading dayflower (Table 8). Among the different level of K fertilizers, $K_0$ (No potassium) showed the highest number and weight (0.18 and 12.41 g). On the contrary, the lowest number and weight (0.13 and 9.38 g) was observed with $K_2$ (30% increased of recommended dose of potassium) treatment.

Number and weight of Spreading dayflower was significantly influenced by level of weeding (Table 9). It is mentioned from the present study that the increasing number of weeding significantly decreased number and weight of Spreading dayflower. The maximum number and weight (0.19 and 13.65g) was recorded in $W_3$ and the minimum number and weight (0.14 and 9.34 g) was achieved by $W_2$ (Two hand weeding at 15 DAS and 30 DAS).

Interaction effect between different level of potassium and weeding not significant effect on number and but significant effect on weight of Spreading dayflower at harvest (Table 10). The highest number and weight of Spreading dayflower (0.21 and 14.89 g) at harvest was observed control (No Potassium and no weeding) ($K_0 \times W_0$). The lowest dry number and weight of spreading dayflower(0.12 and 8.29 g) at harvest was observed in the 30% increased of recommended dose of Potassium with two hand weeding ($K_2 \times W_2$).

## 4.7 Pods number plant$^{-1}$

Number of pods plant$^{-1}$ showed significant variation due to the effects of different levels of potassium (Table 11).The highest number of pod per plant (26.16) was obtained from the grown with the dose of $K_2$ (30% increased of recommended dose of Potassium).The lowest number of pod per plant (23.41) was found when the plants were raised without potassium ($K_0$). Biswash *et al.* (2014), Thesiya *et al.* (2013) and Ali *et al.* (1996) also found similar results.

Number of pods plant$^{-1}$ was significantly influenced by weed management at all growth stages of mungbean (Table 11). It was remarked from the present study that the increasing number of weeding significantly increased number of pods plant$^{-1}$. $W_2$ (Two hand weeding at 15 DAS and 30 DAS) treatment produced maximum number of pods plant$^{-1}$ (26.77). The lowest number of pods plant$^{-1}$ was achieved with $W_0$ (23.12). The result under the present study was in agreement with the findings of Akter *et al.* (2013) and Khan *et al.* (2011). Akter *et al.* (2013) observed that three-stage weeding (Emergence-Flowering and Flowering-Pod setting and pod setting-Maturity) ensured the highest number of pods (22.03) plant$^{-1}$.

Interaction effect between different level of potassium and weeding exerted significant effect on number of branch at all DAS (Table 11). The highest plant height (27.90) was observed in the 30% increased of recommended dose of Potassium with two hand weeding ($K_2 \times W_2$). The lowest plant height (21.08) was observed control (No Potassium and no weeding) ($K_0 \times W_0$).

**Table 11. Effect of potassium, weeding and their interaction on yield attributes of mungbean**

| | Pods plant$^{-1}$ (no.) | Pod length (cm) | Seeds pod$^{-1}$ (no.) | Weight of 1000 seeds (g) |
|---|---|---|---|---|
| Potassium level | | | | |
| $K_0$ | 23.41c | 8.85 | 8.57c | 39.94c |
| $K_1$ | 25.63b | 8.92 | 9.39b | 40.21b |
| $K_2$ | 26.16a | 9.10 | 9.58a | 40.48a |
| CV (%) | 5.02 | 6.42 | 4.02 | 4.88 |
| LSD | 0.243 | - | 0.087 | 0.23 |
| LS | ** | NS | ** | * |
| Weeding level | | | | |
| $W_0$ | 23.12d | 8.64c | 8.47d | 38.83c |
| $W_1$ | 24.66c | 9.07b | 9.03c | 40.38b |
| $W_2$ | 26.77a | 9.40a | 9.80a | 41.48a |
| $W_3$ | 25.71b | 8.72c | 9.42b | 40.16b |
| CV (%) | 5.69 | 6.48 | 4.70 | 4.94 |
| $LSD_{(0.05)}$ | 0.171 | 0.308 | 0.024 | 0.43 |
| LS | ** | ** | ** | * |
| Interaction effect | | | | |
| $K_0 \times W_0$ | 21.08 | 8.85 | 7.72h | 38.56h |
| $K_0 \times W_1$ | 23.10 | 9.41 | 8.46g | 40.11g |
| $K_0 \times W_2$ | 25.14 | 9.38 | 9.21e | 41.21d |
| $K_0 \times W_3$ | 24.31 | 8.77 | 8.90f | 39.89ef |
| $K_1 \times W_0$ | 24.05 | 8.67 | 8.81f | 38.83f |
| $K_1 \times W_1$ | 24.85 | 8.92 | 9.10e | 40.38de |
| $K_1 \times W_2$ | 27.27 | 9.36 | 9.99b | 41.48b |
| $K_1 \times W_3$ | 26.33 | 8.72 | 9.65c | 40.16 |
| $K_2 \times W_0$ | 24.24 | 8.39 | 8.88f | 39.10d |
| $K_2 \times W_1$ | 26.02 | 8.87 | 9.53d | 40.65bc |
| $K_2 \times W_2$ | 27.90 | 9.48 | 10.22a | 41.75a |
| $K_2 \times W_3$ | 26.48 | 8.67 | 9.70c | 40.43b |
| CV (%) | 5.69 | 6.48 | 4.70 | 4.94 |
| $LSD_{(0.05)}$ | - | - | 0.108 | 0.054 |
| LS | NS | NS | * | ** |

Figures in a column followed by different letter(s) differs significantly whereas figures having common letter(s) do not differ significantly from each other as adjusted by LSD.

CV= Coefficient of variation, LS= Level of significance, $LSD_{(0.05)}$= Least significant difference, NS= Not Significant *= Significant at 5% level of Probability, **= Significant at 1% level of Probability.

$K_0$= Control (No Potassium), $K_1$ = Recommended dose of Potassium (R), $K_2$ = 30% increased of Recommended dose of Potassium, $W_0$ = No weeding (control), $W_1$ = One hand weeding at 15 days after sowing (DAS), $W_2$ = Two hand weeding at 15 DAS and 30 DAS, $W_3$ = One paraxon spray at 15 DAS

### 4.8 Pod length (cm)

Not significant variation in pod length in mungbean when different level of potassium fertilizer were applied (Table. 11). But Numerically, $K_2$ (30% increased of recommended dose of Potassium) treatment showed the highest pod length (9.10 cm). The lowest pod length (8.85) was recorded with $K_0$treatment where no potash was applied. The lowest pod length (5.97 cm) was recorded in the $K_0$ treatment where no potassium was applied. Thesiya *et al.* (2013) also found the similar result.

Results presented in Table 11 on pod length influenced by number of weeding were statistically significant. The highest pod length (9.40cm) was recorded in $W_2$ (Two hand weeding at 15 DAS and 30 DAS) and the lowest pod length (8.64 cm) was achieved by $W_0$.

Interaction effect between different level of potassium and weeding showed non-significant effect on pod length at harvest (Table 11). Numerically, the highest plant height (9.48 cm) was observed in the 30% increased of recommended dose of Potassium with two hand weeding ($K_2 \times W_2$). The lowest plant height (8.85 cm)was observed control (No Potassium and no weeding) ($K_0 \times W_0$).

### 4. 9 Seeds pod$^{-1}$ (no.)

Application of potassium fertilizer at different level showed significant variation on number of seed per pod (Table 11). Among the different fertilizer level$K_2$ (30% increased of recommended dose of Potassium) treatment showed the highest number of seed per pod (9.58). The lowest number of seed per pod (8.57) was recorded with $K_0$ treatment where no potash was applied. Optimum fertilizer level might be increased the vegetative growth and development of mungbean that lead to the highest number of seed per pod. Biswash *et al*. (2014), Thesiya *et al.* (2013) and Ali *et al.* (1996) found that number of seeds per pod significantly increased by potassium application.

Results presented in Table 11 on number of seeds pod$^{-1}$ influenced by number of weeding were statistically significant. It was mentioned from the present study that the highest number of seeds pod$^{-1}$(9.80) was recorded in $W_2$ (Two hand weeding at 15 DAS and 30 DAS) and the lowest number of seeds pod$^{-1}$ was achieved by $W_0$ (8.47). The results from $W_1$ and $W_3$ on number of seeds pod$^{-1}$ were intermediate compared to highest and lowest number of seeds pod$^{-1}$. Similar findings were found by Kundu *et al.* (2009). They said that seeds pod$^{-1}$ was highest in the treatment having quizalofop-p-ethyl @ 50 g a.i. ha$^{-1}$at 21 DAE + HW at 28 DAE. This was closely followed by the treatment with quizalofop-p-ethyl @ 50 g a.i. ha$^{-1}$at 14 DAE + HW at 21 DAE.

Interaction effect between different level of potassium and weeding showed significant effect on seeds pod$^{-1}$ at harvest (Table 11). The highest seeds pod$^{-1}$ (10.22) was observed in the 30% increased of recommended dose of Potassium with two hand weeding ($K_2 \times W_2$). The lowest seeds pod$^{-1}$ (7.72) was observed control (No Potassium and no weeding) ($K_0 \times W_0$).

**4.10 Weight of 1000 seeds (g)**

Application of potassium fertilizer at different level showed significant variation on thousand seed weight (Table 11). Among the different fertilizer level $K_2$ (30% increased of recommended dose of Potassium) treatment showed the highest thousand seed weight (40.481 g). The lowest thousand seed weight (39.94) was recorded with $K_0$ treatment where no potash was applied. Biswash *et al.* (2014) found that the increase in potassium levels was significantly increasing the weight of 1000 seeds of mungbean.

Results showed that weight of 1000 seeds influenced by weeding were statistically significant (Table 11). It is mentioned from the present study that the highest weight of 1000 seeds (41.48 g) was recorded in $W_2$ (Two hand weeding at 15 DAS and 30 DAS), whereas the lowest weight of 1000 seeds was achieved by $W_0$ (38.83 g). Similar findings were found by Khan *et al.* (2011). The highest values (40.39 and 38.95 g) of 1000-seeds weight of mungbean in hand weeding plots with 17 and 5 percent increase over control were recorded by them.

Interaction effect between different level of potassium and weeding showed non-significant effect on weight of 1000 seeds at harvest (Table 11). The highest weight of 1000 seeds (41.75 g) was observed in the 30% increased of recommended dose of Potassium with two hand weedings ($K_2 \times W_2$). The lowest seeds pod$^{-1}$ (38.56 g)was observed control (No potassium and no weeding) ($K_0 \times W_0$).

**4.11 Seed yield (t ha$^{-1}$)**

The results of the single effects of different levels of potassium have been shown in (Table 12). From the table it was apparent that $K_2$ (30% increased of recommended dose of Potassium) treatment gave the highest yield (1.50 t ha$^{-1}$). On the contrary, the lowest seed yield (1.21 t ha$^{-1}$) was observed with $K_0$ where no potash was applied. Kurhade *et al.* (2015) and Thesiya *et al.* (2013) found that grain yields were also increased significantly by application of potassium fertilizer.

Grain yield of mungbean influenced by weeding were statistically significant (Table 12). The highest grain yield (1.49 t ha$^{-1}$) was recorded in $W_2$ (two hand weeding at 15 DAS and 30 DAS) which was 23.14% higher than lowest value while the lowest grain yield was achieved by $W_0$ (1.21 t ha$^{-1}$). Khan *et al.* (2011) investigated that hand weeding produced higher yield (1092 and 743.3 kg ha$^{-1}$) of mungbean compared to control (631 and 518.8 kgha$^{-1}$).

Interaction effect between different level of potassium and weeding showed significant effect on seed yield at harvest (Table 12). The highest seed yield (1.63 t ha$^{-1}$) was observed in the 30% increased of recommended dose of Potassium with two hand weeding ($K_2 \times W_2$). The lowest seed yield (1.03 t ha$^{-1}$) was observed control (No Potassium and no weeding) ($K_0 \times W_0$).

**Table 12. Effect of potassium, weeding and their interaction on yields of mungbean**

| Potassium level | Seed yield ($t\ ha^{-1}$) | Stover yield ($t\ ha^{-1}$) | Biological yield ($t\ ha^{-1}$) | HI (%) |
|---|---|---|---|---|
| $K_0$ | 1.21c | 2.47b | 3.67c | 32.80c |
| $K_1$ | 1.38b | 2.64a | 4.02b | 34.29b |
| $K_2$ | 1.50a | 2.61a | 4.10a | 36.49a |
| CV (%) | 4.28 | 5.53 | 4.89 | 6.55 |
| LSD | 0.011 | 0.032 | 0.036 | 0.291 |
| LS | ** | ** | ** | ** |
| Weeding level | | | | |
| $W_0$ | 1.21d | 2.42d | 3.63d | 33.31d |
| $W_1$ | 1.33c | 2.54c | 3.87c | 34.32c |
| $W_2$ | 1.49a | 2.71a | 4.20a | 35.47a |
| $W_3$ | 1.41b | 2.62b | 4.03b | 34.99b |
| CV (%) | 4.08 | 5.63 | 4.69 | 5.55 |
| $LSD_{(0.05)}$ | 0.031 | 0.027 | 0.031 | 0.150 |
| LS | ** | ** | ** | ** |
| Combined effect | | | | |
| $K_0 \times W_0$ | 1.03h | 2.28g | 3.31h | 31.10i |
| $K_0 \times W_1$ | 1.18g | 2.44f | 3.62g | 32.61h |
| $K_0 \times W_2$ | 1.34d | 2.60c | 3.94e | 34.02f |
| $K_0 \times W_3$ | 1.28ef | 2.54de | 3.81f | 33.48g |
| $K_1 \times W_0$ | 1.26f | 2.52e | 3.77f | 33.30g |
| $K_1 \times W_1$ | 1.32de | 2.58cd | 3.89e | 33.83f |
| $K_1 \times W_2$ | 1.51b | 2.75a | 4.28b | 35.27d |
| $K_1 \times W_3$ | 1.44c | 2.70b | 4.13cd | 34.75e |
| $K_2 \times W_0$ | 1.35d | 2.45f | 3.80f | 35.53c |
| $K_2 \times W_1$ | 1.49bc | 2.59c | 4.08d | 36.53b |
| $K_2 \times W_2$ | 1.63a | 2.76a | 4.37a | 37.13a |
| $K_2 \times W_3$ | 1.53b | 2.63c | 4.15c | 36.76b |
| CV (%) | 4.08 | 5.63 | 4.69 | 5.55 |
| $LSD_{(0.05)}$ | 0.054 | 0.045 | 0.054 | 0.260 |
| LS | ** | ** | ** | * |

Figures in a column followed by different letter(s) differs significantly whereas figures having common letter(s) do not differ significantly from each other as adjusted by LSD.

CV= Coefficient of variation, LS= Level of significance, $LSD_{(0.05)}$= Least significant difference, NS= Not Significant *= Significant at 5% level of Probability, **= Significant at 1% level of Probability.

$K_0$= Control (No Potassium), $K_1$ = Recommended dose of Potassium (R), $K_2$ = 30% increased of Recommended dose of Potassium, $W_0$ = No weeding (control), $W_1$ = One hand weeding at 15 days after sowing (DAS), $W_2$ = Two hand weeding at 15 DAS and 30 DAS, W3 = One paraxon spray at 15 DAS

### 4.12 Stover yield (t $ha^{-1}$)

Different level of potassium fertilizers showed significant variations in respect of stover yield of mungbean (Table 12). Among the different level of K fertilizers, $K_1$ (Recommended dose of Potassium).showed the highest stover yield (2.64 t $ha^{-1}$), which was statistically similar with $K_2$ (30% increased of recommended dose of Potassium) treatment. On the contrary, the lowest stover yield (2.47 t $ha^{-1}$) was observed with $K_0$ treatment. Biswash*et al.* (2014) and Thesiya*et al.* (2013) also found the similar result in mungbean and blackgram, respectively.

Stover yield of mungbean varied significantly due to different weed managements (Table 12). The highest stover yield (2.71 t $ha^{-1}$) was observed from $W_2$ (Two hand weeding at 15 DAS and 30 DAS) which was statistically similar with W1 and W3 while the lowest stover yield (2.42 t $ha^{-1}$) from $W_0$.

Interaction effect between different level of potassium and weeding showed non-significant effect on strove yield (t $ha^{-1}$)at harvest (Table 12). The highest strove yield (2.76 t $ha^{-1}$) was observed in the 30% increased of recommended dose of Potassium with two hand weeding ($K_2 \times W_2$) which was statistically similar with ($K_1 \times W_2$). The lowest strove yield (2.28 t $ha^{-1}$) was observed control (No Potassium and no weeding) ($K_0 \times W_0$).

### 4.13 Biological yield (t $ha^{-1}$)

Different level of potassium fertilizers showed significant variations in respect of biological yield of mungbean (Table 12). Among the different level of K fertilizers, $K_2$ (30% increased of recommended dose of Potassium)showed the highest biological yield (4.10 t $ha^{-1}$), which was statistically similar with $K_2$. On the contrary, the lowest biological yield (4.20 t $ha^{-1}$) was observed with $K_0$ treatment.

Biological yield was significantly influenced by level of weeding (Table 12). It was mentioned from the present study that the increasing number of weeding significantly increased biological yield. The maximum biological yield (4.10 t $ha^{-1}$) was recorded in $W_2$ (Two hand weedings at 15 DAS and 30 DAS) and the minimum biological yield was achieved by $W_0$ (3.67 t $ha^{-1}$). The results from $W_1$ and $W_3$ on biological yield were intermediate compared to highest and lowest biological yield.

Interaction effect between different level of potassium and weeding showed significant effect on biological yield at harvest (Table 12). The highest biological yield (4.37t $ha^{-1}$) was observed in the 30% increased of recommended dose of Potassium with two hand weeding ($K_2 \times W_2$). The lowest biological yield (3.31t $ha^{-1}$)was observed control (No Potassium and no weeding) ($K_0 \times W_0$).

**4.14 Harvest Index**

Potassium fertilizers showed significant variations in respect of harvest index of mungbean (Table 12). $K_2$ (30% increased of recommended dose of potassium) showed the highest harvest index (36.49 %), which was statistically similar with $K_2$. On the contrary, the lowest harvest index (32.80 %) was observed with $K_0$ treatment.

Harvest index was significantly influenced by weeding (Table 12). It stated from the present study that the highest harvest index (38.13%) was recorded in $W_2$ (two hand weeding at 15 DAS and 30 DAS) and the lowest harvest index was achieved by $W_0$ (30.94%). The results from $W_1$and $W_3$ on harvest index showed intermediate results compared to highest and lowest harvest index.

Interaction effect between different level of potassium and weeding showed non-significant effect on harvest Index at harvest (Table 12). The highest harvest Index (37.13%) was observed in the 30% increased of recommended dose of potassium with two hand weeding ($K_2 \times W_2$). The lowest harvest index (31.10%) was observed control (No Potassium and no weeding) ($K_0 \times W_0$).

# Chapter 5
# SUMMARY AND CONCLUSION

The experiment was conducted at the research plot of the Department of Agronomy, Sher-e-Bangla Agricultural University, Dhaka during the period from March, 2017 to May, 2017 to study the effect of potassium levels and weed control methods on the growth and yield of mungbean. In experiment, the treatment consisted of three potassium level, viz., $K_0$= Control (No Potassium), $K_1$ = Recommended dose of Potassium (R), $K_2$ = 30% increased of Recommended dose of Potassium and four weed control methods viz., $W_0$ = No weeding (control), $W_1$ = One hand weeding at 15 days after sowing (DAS), $W_2$ = Two hand weeding at 15 DAS and 30 DAS, W3 = One paraxon spray at 15 DAS. The experiment was laid out in a two factors randomized complete block design (RCBD) with three replications. The seeds of BARI mung-6 variety were sown on 10$^{th}$ March, 2017 at the rate of 45 kg ha$^{-1}$. Necessary intercultural operations were done as and when necessary.

Potassium showed statistically significant variation in respect of plant height, number of branches plant$^{-1}$, number of leaflets plant$^{-1}$, dry weight plant$^{-1}$ at 25, 35, 45 and 55 DAS. At harvest potassium level also influence significantly the number and dry weight of smooth crabgrass, purple nutsedge, jungle rice, Bermuda grass, indian goose grass, alligator weed, green amaranth, common purslane and spreading dayflower showed significant effect on potassium level also showed significant effect on pods plant$^{-1}$, seeds pod$^{-1}$, weight of 1000 seeds , seed yield, stover yield, biological yield and harvest index of mugbean.The interaction effects on plant height, number of branches plant$^{-1}$, number of leaflets plant$^{-1}$, dry weight plant$^{-1}$ at 15 DAS and pod length were found non-significant.

Weed control methods showed statistically significant effects on plant height, number of branches plant$^{-1}$, number of leaflets plant$^{-1}$, dry weight plant$^{-1}$ at 15, 25, 35, 45 and 55 DAS. At harvest, weed number and dry weight of smooth crabgrass, purple nut sedge, jungle rice, bermuda grass, indian goose grass, alligator weed, green amaranth, common purslane and spreading dayflower, number of pods plant$^{-1}$, number of seeds pod$^{-1}$, weight of 1000 seeds , seed yield, stover yield, biological yield and harvest index were also significantly influence by weed control methods.

Interaction effect of potassium and weeding showed statistically significant variation on plant height, number of branches plant$^{-1}$, number of leaflets plant$^{-1}$, dry weight plant$^{-1}$ at 25, 35, 45 and 55 DAS. Number and dry weight of smooth crabgrass, purple nutsedge, jungle rice, bermuda grass, indian goose grass, alligator weed, green amaranth, common purslane and spreading dayflower on seeds pod$^{-1}$, weight of 1000 seeds , seed yield, stover yield, biological yield and harvest index were also influence significantly by interaction of potassium level and weed control methods.

Result revealed that $K_2$ (30% increase of recommended potassium) showed the highest plant height (16.61, 27.60, 36.87, 42.01 and 43.90 cm at 15, 25, 35, 45 and 55 DAS, respectively). At 15, 25, 35, 45 and 55 DAS, the highest plant height (16.62, 27.63, 37.43, 42.51, and 44.42 cm, respectively) was recorded in $W_2$ (two hand weeding at 15 DAS and 30 DAS). The highest plant height (16.98, 27.71, 37.92, 43.35 and 45.30 cm at 15, 25, 35, 45 and 55 DAS, respectively) was observed $K_2 \times W_2$ treatment. The lowest plant height (16.00, 24.03, 32.10, 37.41 and 39.09 cm at 15, 25, 35, 45 and 55 DAS, respectively) was observed $K_0 \times W_0$ treatment.

Among the different fertilizer level $K_2$treatment, showed the highest number of branches plant$^{-1}$ (4.28, 6.90, 36.87, 9.22, 9.81 and 10.25 cm at 15, 25, 35, 45 and 55 DAS, respectively). At 15, 25, 35, 45 and 55 DAS, the highest number of branches plant$^{-1}$ (4.38, 7.06, 9.36, 9.96 and 10.40 respectively) was recorded in $W_2$ (two hand weeding at 15 DAS and 30 DAS). The highest number of branch (4.51, 7.26, 9.48, 10.09 and 10.54 cm at 15, 25, 35, 45, and 55 DAS, respectively) was observed $K_2 \times W_2$. The lowest plant height (3.77, 6.08, 8.12, 8.64 and 9.02 at 15, 25, 35, 45, and 55 DAS, respectively) was observed $K_0 \times W_0$.

$K_2$ treatment, showed the highest number of leaflets plant$^{-1}$ (5.72, 11.31, 13.96, 15.41 and 16.41 at 15, 25, 35, 45 and 55 DAS, respectively). At 15, 25, 35, 45, 55 DAS and harvest, the highest number of leaflets plant$^{-1}$ (5.87, 11.57, 14.22, 15.67 and 16.67 respectively) was recorded in $W_2$. The highest plant height (6.04, 11.90, 14.55, 16.00 and

17.00 at 15, 25, 35, 45, and 55 DAS, respectively) was observed in $K_2 \times W_2$. The lowest plant height (5.06, 9.96, 12.61, 14.06 and 15.06 cm at 15, 25, 35, 45, and 55 DAS, respectively) was observed in $K_0 \times W_0$.

$K_2$ treatment showed the highest dry weight of plant$^{-1}$ (0.71, 2.38, 5.36, 6.14 and 7.07 g at 15, 25, 35, 45 and 55 DAS, respectively). At 15, 25, 35, 45 and 55 DAS, the maximum of dry weight plant$^{-1}$ (1.13, 3.31, 9.19, 11.69 and 13.37 g, respectively) was recorded in $W_2$ (Two hand weeding at 15 DAS and 30 DAS). The highest dry weight plant$^{\mathbf{-1}}$ (0.75, 2.50, 5.54, 6.34 and 7.30g at 15, 25, 35, 45, and 55 DAS, respectively) was observed in $K_2 \times W_2$. The lowest dry weight plant$^{\mathbf{-1}}$ (0.63, 2.08, 4.80, 5.49 and 6.33 g at 15, 25, 35, 45, and 55 DAS, respectively) was observed in $K_0 \times W_0$.

The lowest number and weight of smooth crabgrass (17.25 and 71.31 g), purple nutsedge (31.98 and 23.67 g), jungle rice (32.65 and 125.26 g), bermuda grass (26.84 and 111.50 g), Indian goose grass (1.24 and 9.81 g), Alligator weed (9.45 and 0.91 g), Green amaranth (1.80 and 0.27 g), Common purslane (0.18 and 0.10 g) and Spreading dayflower (0.18 and 12.41 g) was observed with $K_2$ (30% increased of recommended dose of Potassium).

The lowest number and weight of smooth crabgrass (17.29 and 24.93 g), purple nutsedge (32.28 and 23.88 g), jungle rice (32.14 and 126.25 g), bermuda grass (3.87 and 0.13 g), Indian goose grass (0.95 and 7.48 g), Alligator weed (9.53 and 0.92 g), Green amaranth (1.82 and 0.27 g), Common purslane (0.19 and 0.11 g) and Spreading dayflower (0.14 and 9.34 g) was achieved by $W_2$ treatment.

The highest number and weight of smooth crabgrass (27.35 and 113.60 g), purple nutsedge (50.71 and 37.52 g), jungle rice (52.43 and 198.71 g), bermuda grass (6.27 and 0.18 g), Indian goose grass (1.49 and 11.84 g), Alligator weed (14.98 and 1.44 g), Green amaranth (2.85 and 0.43 g), Common purslane (0.28 and 0.15 g) and Spreading dayflower (0.21 and 14.89 g) at harvest was observed in $K_0 \times W_0$. The lowest dry number and weight of smooth crabgrass (13.68 and 55.50 g), purple nutsedge (25.37 and 18.77 g), jungle rice (24.58 and 99.17 g), bermuda grass (3.03 and 0.10 g), Indian goose grass (0.75 and 5.85 g), Alligator weed (7.49 and 0.74 g), Green amaranth (1.43 and 0.21

g), Common purslane (0.15and 0.08 g) and Spreading dayflower (0.12 and 8.29 g) at harvest was observed in ($K_2 \times W_2$).

The highest number of pod plant$^{-1}$ (26.16), pod length (9.10 cm), number of seed per pod (8.57), 1000 seed weight (40.481 g), seed yield (1.50 t ha$^{-1}$), stover yield (2.64 t ha$^{-1}$), biological yield (4.10 t ha$^{-1}$) and harvest index (36.49%) was obtained from the treatment $K_2$ (30% increased of recommended dose of Potassium).

$W_2$ (two hand weeding at 15 DAS and 30 DAS) treatment produced maximum number of pods plant$^{-1}$ (26.77), pod length (9.40cm), number of seeds pod$^{-1}$ (9.80), highest weight of 1000 seeds (41.48 g), seed yield (1.49 t ha$^{-1}$), stover yield (2.71 t ha$^{-1}$), biological yield (4.10 t ha$^{-1}$) and harvest index (38.13%).

The highest plant height (27.90), pod length (9.48 cm), seeds pod$^{-1}$ (10.22), weight of 1000 seeds (41.75 g), seed yield (1.63 t ha$^{-1}$), stover yield (2.76 t ha$^{-1}$), biological yield (4.37 t ha$^{-1}$) and harvest index (37.13%) was observed in the 30% increased of recommended dose of Potassium with two hand weedings ($K_2 \times W_2$). The lowest plant height (21.08cm) was observed in control (No Potassium and no weeding) ($K_0 \times W_0$).

The results in this study indicated that the plants performed better in respect of seed yield and yield contributing characters in $K_2 \times W_2$ (30% increased of recommended dose of potassium with two hand weeding at 15 DAS and 30 DAS) compared to other treatment combinations.

## References

Afzal, M. A., Murshad, A. N. M. M., Bakar, M. M. A., Hamid, A. and Salahuddin, A. B. M. (2008). Mungbean Cultivation in Bangladesh, Pulse Research Station, Bangladesh Agricultural Research Institute, Gazipur, Bangladesh, p.13.

Ahmad, M. S. A., Hossain, M., Ijaz, S. and Alvi, A. K. (2008). Photosynthetic performance of two mungbean (*Vigna radiata*) cultivars under lead and copper stress. *Intl. J. Agric. Biol.* **10:** 167–172.

Akter, R., Samad, M. A., Zaman, F. and Islam, M. S., (2013). Effect of weeding on the growth, yield and yield contributing characters of mungbean (*Vigna radiata* L.). *J. Bangladesh Agril. Univ.* **11**(1): 53–60.

Ali A., Malik M. A., Ahmad R. and Atif, T. S. (1996). Response of mungbean to potassium fertilizer. *Pak. J. Agric. Sci*. **33(**1-4): 44-45.

Amtmann, A., Troufflard S., Armengaud P. (2008). The effect of potassium nutrition on pest and disease resistance in plants. Physiol. Plantarum. **133**: 682–691.

Ansari, A. H., Kakar, A. A., Tareen, A. B., Barecht, A. R. and Kakar, G. M. (2000). Planting pattern and irrigation level effects on growth, yield components and seed yield of soybean (*Glycine max* L.). *Pakistan J. Agric. Sci.* **37**: 61–4.

Anwar, S., Shah, W. A., Bakht, J. and Jabeen, U. (2004). Comparison of sorghum extracts, chemical and hand weeding management in wheat Crop. *J. Agron.* **3**(1): 59-67.

Awan, F. K., Zahid, M. A. and Yaqoob, M. (2009). Weed management in mungbean (*Vigna radiata* L.) using different methods and row spacing. *Pakistan J. Weed Sci. Res.* **15**(4): 269-274.

BARC. (2012). Fertilizer Recommendation Guide, Bangladesh Agric. Res. Council, p. 85-87.

Batish, D. R., Singh, H. P., Saxena, D. B. and Kohli, R. K. (2002). Weed suppressing ability of parthenin-a sesquiterpene lactone from *Parthenium hysterophorus*.

Proceeding of a conference, 13-15 August, 2002.New Zealand Plant Protection Society. Rotoura, New Zealand: 218-221.

BBS (Bangladesh Bureau of Statistic). (2014). Major and minor crops statistics.wwbbs.gov. bd.

BBS (Bangladesh Bureau of Statistics). (2015). Statistical Yearbook of Bangladesh. Stat. Div., Minis. Plan., Govt. People’s Repub. Bangladesh, Dhaka. p. 37.

Biswash, M. R., Rahman, M. W., Haque, M. M., Sharmin, M. and Barua, R. (2014). Effect of potassium and vermicompost on the growth, yield and nutrient contents of mungbean (BARI Mung 5). *Open Sci. J. Biosci. Bioeng.* **1**(3): 33-39.

Bueren, E. T. L., Struik, P. C. and Jacobsen, E. ( 2002). Ecological concepts in organic farming and their consequences for an organic crop ideotype. *J. Life Sci.* **50**: 1-26.

Cakmak, I. (2005). The role of potassium in alleviating detrimental effects of abiotic stresses in plants. *J. Plant Nutr. Soil Sci*. **168:** 521–530.

Chanda, R., Singh, N. P. and Singh, V. K. (2003). Effect of weed control treatments on weed and grain yield of late sown urdbean (*Vigna mungo* L.) during kharif season. *Ind. J. Weed Sci*. **36**: 127-128.

Chattha, M. R., Jamil, M. and Mahmood, T. Z. (2007).Yield and Yield Components of Mungbean as Affected by Various Weed Control Methods under Rain-fed Conditions of Pakistan. *Int. J. Agri. Biol.* **9** (1):114-119.

Chotechuen, S. (1996) Breeding of mungbean for resistance to various environmental stresses. In: Proceedings of the workshop on mungbean germplasm. Bangkok.

Devi, R. G., Pandiyarajan, V and Gurusaravanan, P. (2012). Alleviating effect of IAA on salt stressed Phaseolus mungo (L.) with reference to growth and biochemical characteristics. *Recent Res. and Technol*. **4**(3):22-24.

Dong, H., Kong X., Li W., Tang W. and Zhang D. (2010). Effects of plant density and nitrogen and potassium fertilization on cotton yield and uptake of major nutrients in two fields with varying fertility. *Field Crop Res*. **119:** 106–113.

Dungarwal, H. S., Chaplot, P. C. and Nagda, B. L. (2003). Chemical weed control in mungbean (*Phaseolus radiatus* L.). *Indian J. Weed Sci*., **35**: 283-284.

Elias, S. M., Hossain, M. S., Sikder, F. S., Ahmed, J. and Karim, M. R. (1986). Identification of constraints to pulse production with special reference to present farming systems. Annual Report of the Agricultural Economics Division, BARI, Joydebpur. p.1

Elliot, P. C. and Moody, K. (1990). Evaluation of various weed control practices in maize (*Zea mays*) in Misamis Oriental. *Philippine J. Weed Sci*., **17**: 39-50.

Fooladivanda, Z., Hassanzadehdelouei, M. and Zarifinia, M. (2014). Effects of water stress and potassium on quantity traits of two varieties of mung bean (*Vigna radiata* L.*). Cercetări Agronomice în Moldova*. **1**(157): 107-114.

Ganga, N. Singh, R. K., Singh, R. P., Choudhury, S. K. and Upadhyay, P. K. (2014). Effect of potassium level and foliar application of nutrient on growth and yield of late sown chickpea (*Cicer arietinum* L.). *Environ. Ecol.,* **32**(1A): 273-275.

Gomez, K. A. and Gomez, A. A. (1984). Statistical Procedure for Agricultural Research. 2nd Edn. John Wiley and Sons, New York. pp. 207-215.

Hossain, M. A., Karim, M. F. and Maniruzzaman, A. F. M. (1990). Response of summer mungbean to levels of field management. *Appl. Agric. Res*., **5**: 289-92.

Hussain, F., Malik, A. U., Haji, M. A. and Malghani, A. L. (2011). Growth and yield response of two cultivars of mungbean (*Vigna radiata* L.) to different potassium levels. *J. Animal Plant Sci.,* **21**(3): 622-625.

Ibrahim (2013). Effect of pre- emergence herbicides on weed control and performance of cowpea in samaru. *J. Agric. Sci***., 8**(2): 322-332.

Islam, M. A., Mamun, A. A., Bhuiyan, M. S. U. and Hossain, S. M. A. (1989). Weed biomass and grain yield in wheat as affected by seed rate and duration of weed competition. *Bangladesh J. Agril. Sci.*, **14**: 213-224.

Ismail, A. M., and Hall, A. E. (2002).Semi-dwarf and standard height cowpea responses to row spacing in different environment. *Crop Sci*., **40:** 1618-1624.

Kant, S., Kafkafi U. (2002). Potassium and Abiotic Stresses in Plants. In: Pasricha N. S., Bansal S. K., editors. Potassium for Sustainable Crop Production. Potash Institute of India; Gurgaon, India: pp. 233–251.

Khajanji, S. N., Cautam, R. C. and Patel, J. R. (2002). Effect of Tillage and weed control methods on growth and yield of maize. *J. Maharashtra Agric. Univ.,* **27**(3): 277-279.

Khaliq, A., Aslam, Z. and Cheema, Z. A. 2002). Efficacy of weed management strategies in mungbean (*Vigna radiate* L.). *Int. J. Agric. Biol.*,**4:** 237–239.

Khan, R. U., Rashid, A. and Khan, M. S. (2011). Impact of various rates of pendimethalin herbicide on weed control, seed yield and economic returns in mungbean under rainfed conditions. *J. Agric. Res.* **49**(4): 171-177.

Khan, S., Shah, S., Akbar, H. and Khan, S. (2001). Effects of planting geometry on yield and yield components in mungbean. *Sarhad J. Agric*. **17**(4): 519-524.

Khattak, G. S. S., Ashraf, M. and Khan, M. S. (2004). Assessment of genetic variation for yield and yield components of mungbean (*Vigna radiata* L.) using generation mean analysis. *Pakistan J. Bot.,* **36**(3): 583-588.

Khokar, R. K. and Warsi, A. S. (1987). Fertilizer response studies in gram. *Indian J. Agron.* **32**(4): 362-364.

Kumar, P., Kumar, P., Singh, T., Singh, A. K. and Yadav, R. I. (2014). Effect of different potassium levels on mungbean under custard apple based agri-horti system. *Afr. J. Agric. Res.,* **9**(8): 728-734.

Kumar, S. and Kairon, M. S. (1988). Effects of time of weed removal on yield of green gram (*Vigna radiata*). *Indian J. Agric. Sci.,* **58**: 859-860.

Kumar, U., Singh, S. P. and Vikas. (2005). Variability and character association in mungbean [*Vigna radiata* (L.)Wilczek]. *New Agriculturist*, **16**(1/2): 23-28.

Kundu, R., Bera, P. S. and Chari, K. B. (2009). Effect of different weed management practices in summer mungbean [*Vigna radiata* L.] under new alluvial zone of West Bengal. *J. of Crop and Weed*, **5**(2): 117-121.

Kurhade, P. P., Sethi, H. N. and Zadode, R. S. (2015). Effect of different levels of potassium on yield, quality, available nutrient and uptake of blackgram. *Int. J. Agric. Sci.*, **11**(1): 175-178.

Lipton, M. (2001). Reviving global poverty reduction: what role for genetically modified plants. *J. Intl. Develop*. **13**: 823–846.

Madukwe, D. K., Ogbuehi, H. C. and Onuh, M. O. (2012). Effects of Weed Control Methods on the Growth and Yield of Cowpea (*Vigna unguiculata* (L.) Walp) under Rain-Fed Conditions of Owerri. *American-Eurasian J. Agric. Environ. Sci.* **12** (11): 1426-1430.

Malik, R. S., Yadav, A., and Malik, R. K. (2005). Efficacy of trifluralin, linuron and acetachlor against weeds in mungbean (*Vigna radiata*). *Indian J. Weed Sci.*, **32**: 181–185.

Mansoor, M., Ahmad, H. K., Khan, H. and Yaqoob, M. (2004). Development of economical weed management strategies for mungbean (*Vigna radiata* L.). *Pakistan J. Weed Sci. Res*., **10**: 151–160.

Marschner, H. (2015). Mineral nutrition of higher plants. 2nd ed. London Academic Press.

Marschner, P. ( 2012). Marschner's Mineral Nutrition of Higher Plants. 3rd ed. Academic Press; London, UK: pp. 178–189.

Mengel, K. and Kirkby, E. A. (2001): Principles of Plant Nutrition. 5$^{th}$ ed. Kluwer Academic Publishers, Dordrecht, Boston, London, 849.

Mirjha, P. R., Prasad, S. K., Singh, M. K., Baghel, P. and Paikra, R. H. (2013). Productivity and economics of mungbean as influenced by chemical weed Control. *Ann. Agric. Res. New Series.*, **34**(2):185-188.

MoA (Ministry of Agriculture) (2005). Hand Book of Agricultural Statistics, December, 2005, p.14.

Muhammad, A. N., Rashid, A. and Ahmad, M. S. (2004). Effect of seed inoculation and different fertilizer levels on the growth and yield of mungbean (*Vigna radiata* L.). *J. Agron.* **3:** 40-42.

Musa, M., Chawdhury, G. A., Khalid, A. H., Shahzad, M. A. and Cheema, N. M. (1996). Weed competition studies in mungbean. Absts. 5th. Pakistan Weeds Sci. Conf. March 3-5.

Pandey, J. and Mishra, B. N. (2003). Effect of weed management practices in a rice mustard-mungbean cropping system on weeds and yield of crops. *Annals Agric. Res*., **24:** 737–742.

Pettigrew, W. T. (2008). Potassium influences on yield and quality production for maize, wheat, soybean and cotton. *Physiol. Plantarum*. **133:** 670–681.

Punia, S. S., Malik, R. S., Yadav, A. and Rinwa, R. S. (2004). Effect of varying density of *Cyperus rotundus*, *Echinochloa colonum and Trianthema portulacastrum* on mungbean. *Indian J. Weed Sci.,* **36**: 280–281.

Raman, R.(2006). Impact of weed management practices on growth and yield of urdbean (*Vigna mungo* L.). *Crop Res.,* **32**: 24-26.

Rehman, A. and Ullah, E. (2009). Model farming. Dawn the internet edition; May 13, 2009.

Riaz, M., Malik, M. A., Mahmood, T. Z. and Jamil, M. (2006). Effect of various weed control methods on yield and yield components of wheat under different cropping patterns. *Int. J. Agri. Biol.,* **8**(5): 636–640.

Romheld, V. and Kirkby, E. A. (2010). Research on potassium in agriculture: Needs and prospects. *Plant Soil*. **335:** 155–180.

Saikia, T. P. and Jitendra, P. (1999). Weed shift in maize (*Zea mays*)- chickpea (*Cicer arietinum*) cropping system. *Indian J. Agron*., **44**(2): 246-249.

Singh, G., Khajuria, V., Gill, R. and Lal, S. B. (2001). Effect of weed management practices in summer mungbean (*Vigna radiata*). *Biennial Conf. Indian Soc. Weed Sci.* March 12-14, Pp. 22-23.

Sitthigripong, R. and Alcantara, P. F. (1998). Amino acid supplementation of high mungbean meal vermicelli by-product diets for growing-finishing pigs. *Kasetsart J. Nat. Sci.*, **32**(2): 242-252.

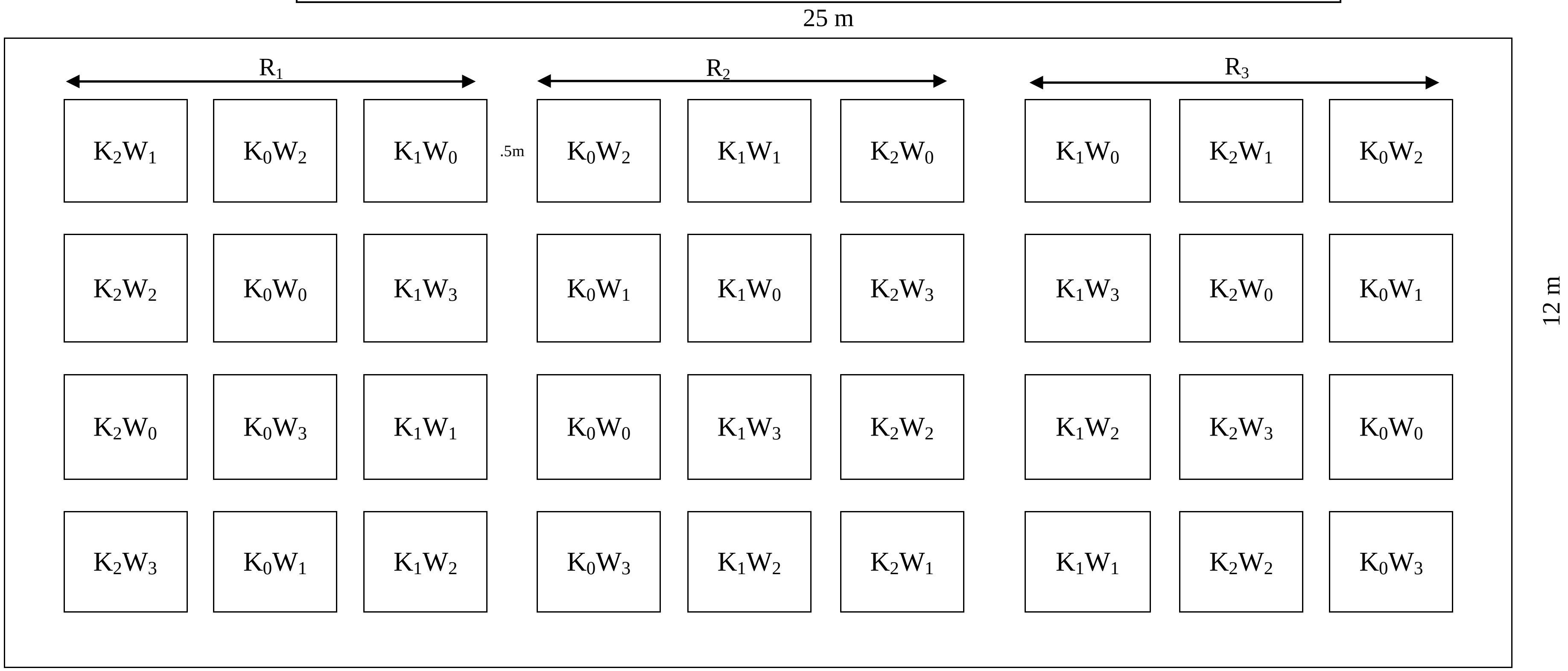
Tariq, M., Khaliq, A. and Umar, M. (2001). Effect of phosphorus and potassium application on growth and yield of mungbean (*Vigna radiata* L.). *J. Biol. Sci.*, **1:** 427-428.

Thesiya, N. M., Chovatia, P. K. and Kikani, V. L. (2013). Effect of potassium and sulphur on growth and yield of black gram (*Vigna mungo* L. Hepper) under rainfed condition. *Legume Res.*, **36**(3): 255.

Thirtle, C., Lin, L. and Piesse, J. (2003). The impact of research-led agricultural productivity growth on poverty reduction in Africa, Asia and Latin America. *World Develop*, **3**: 1959-1976.

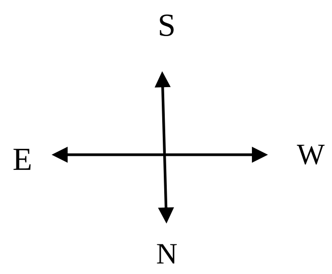
Yadav, V. K. and Singh, S. P. (2005). Losses due to weeds and response to pendimethalin and fluchloralin in varieties of summer sown *Vigna radiata*. *Annals Plant Protect. Sci*, **13**: 454–457.

Appendix I. A Field lay out of the two factor experiment in Split Plot Design




Legend:

1. Width of the plot = 2.3 m
2.length of the plot = 2.4 m
3. Space around the land = 0.75m
4. Space between the block =0.50 m
5. Space between the plot =0.30 m



**Appendix II: Soil characteristics of experimental farm of Sher-e-Bangla Agricultural University are analyzed by soil Resources Development Institute (SRDI), Farmgate, Dhaka.**

**A. Morphological characteristics of the experimental field**

| **Morphological features** | **Characteristics** |
|---|---|
| Location | Farm, SAU, Dhaka |
| AEZ | Modhupur tract (28) |
| General soil type | Shallow red brown terrace soil |
| Land type | High land |
| Soil series | Tejgaon |
| Topography | Fairly leveled |
| Flood level | Above flood level |
| Drainage | Well drained |
| Cropping pattern | **N/A** |

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

| **B. Physical and chemical properties of the initial soil Characteristics** | **Value** |
|---|---|
| Practical size analysis | |
| Sand (%) | 16 |
| Silt (%) | 56 |
| Clay (%) | 28 |
| Silt + Clay (%) | 84 |
| Textural class | Silty clay loam |
| pH | 5.56 |
| Organic matter (%) | 1.00 |
| Total N (%) | 0.06 |
| Available P (µ gm/g soil) | 42.64 |
| Available K (me/100 g soil) | 0.13 |

Source: SRDI

**Appendix III. Monthly average temperature, relative humidity and total rainfall of the experimental site during the period from October 2016 to March 2017**

| Month | Air temperature ($^0C$) | | R. H. (%) | Total rainfall (mm) |
|---|---|---|---|---|
| | Maximum | Minimum | | |
| February,17 | 27.1 | 16.7 | 67 | 3 |
| March,17 | 31.4 | 19.6 | 54 | 11 |
| April, 17 | 36.4 | 22.5 | 63 | 17 |
| May, 17 | 34.4 | 21.46 | 68 | 39 |

Source: Bangladesh Metrological Department (Climate and weather division) Agargaon, Dhaka

**Appendix IV. Analysis of variance (ANOVA) of plant height of mungbean at different days after sowing (DAS)**

| Sources of variation | d. f | Mean Square values of plant height at | | | | |
|---|---|---|---|---|---|---|
| | | 15 DAS | 25 DAS | 35 DAS | 45 DAS | 55 DAS |
| Replication | 2 | $0.011^{NS}$ | 0.030 | 0.054 | 0.047 | 0.053 |
| Factor A | 2 | $0.703^{NS}$ | $9.597^{**}$ | $15.711^{**}$ | $19.446^{**}$ | $21.248^{**}$ |
| Error | 4 | 0.023 | 0.059 | 0.106 | 0.204 | 0.221 |
| Factor B | 3 | $0.959^{NS}$ | $12.890^{**}$ | $20.436^{**}$ | $21.698^{**}$ | $23.708^{**}$ |
| AB | 6 | $0.225^{NS}$ | $0.589^{**}$ | $0.842^{**}$ | $2.934^{*}$ | $4.583^{*}$ |
| Error | 18 | 0.042 | 0.109 | 0.194 | 0.381 | 0.419 |
| Total | 35 | | | | | |

NS= Not Significant, *= Significant at 5% level of Probability, **= Significant at 1% level of Probability.

**Appendix V. Analysis of variance (ANOVA) of number of branch plant$^{-1}$ of mungbean at different days after sowing (DAS)**

| Sources of variation | d. f | Mean Square value of Number of branches plant$^{-1}$ at | | | | |
|---|---|---|---|---|---|---|
| | | 15 DAS | 25 DAS | 35 DAS | 45 DAS | 55 DAS |
| Replication | 2 | 0.002 | 0.005 | 0.009 | 0.010 | 0.011 |
| Factor A | 2 | 0.210** | 0.550** | 0.895** | 1.010** | 1.113** |
| Error | 4 | 0.002 | 0.005 | 0.009 | 0.010 | 0.011 |
| Factor B | 3 | 0.293** | 0.754** | 1.190** | 1.347** | 1.473** |
| AB | 6 | 0.041** | 0.012* | 0.063** | 0.045* | 0.058** |
| Error | 18 | 0.003 | 0.009 | 0.017 | 0.018 | 0.021 |
| Total | 35 | | | | | |

NS= Not Significant, *= Significant at 5% level of Probability, **= Significant at 1% level of Probability.

**Appendix VI. Analysis of variance (ANOVA) of number of leaflets of mungbean at different days after sowing (DAS)**

| Sources of variation | d. f | Mean Square value of Number of leaflets plant $^{-1}$ at | | | | |
|---|---|---|---|---|---|---|
| | | 15 DAS | 25 DAS | 35 DAS | 45 DAS | 55 DAS |
| Replication | 2 | 0.003 | 0.014 | 0.011 | 0.004 | 0.019 |
| Factor A | 2 | 0.378** | 1.475** | 1.475** | 3.475** | 4.125** |
| Error | 4 | 0.003 | 0.014 | 0.015 | 0.025 | 0.019 |
| Factor B | 3 | 0.523** | 2.013** | 2.028** | 3.028** | 3.398** |
| AB | 6 | 0.012$^{NS}$ | 0.082* | 0.074* | 0.156** | 0.109** |
| Error | 18 | 0.006 | 0.022 | 0.021 | 0.029 | 0.019 |
| Total | 35 | | | * | * | * |

NS= Not Significant, *= Significant at 5% level of Probability, **= Significant at 1% level of Probability.

**Appendix VII. Analysis of variance (ANOVA) of dry weight plant$^{-1}$ of mungbean at different days after sowing (DAS)**

| Sources of variation | d. f | Mean Square value of Dry weight plant$^{-1}$ at | | | | |
|---|---|---|---|---|---|---|
| | | 15 DAS | 25 DAS | 35 DAS | 45 DAS | 55 DAS |
| Replication | 2 | 0.000 | 0.000 | 0.001 | 0.001 | 0.001 |
| Factor A | 2 | 0.008** | 0.011** | 0.278** | 0.365** | 0.476** |
| Error | 4 | 0.001 | 0.001 | 0.002 | 0.003 | 0.004 |
| Factor B | 3 | 0.002** | 0.008** | 0.332** | 0.435** | 0.564** |
| AB | 6 | 0.001** | 0.002** | 0.019** | 0.039* | 0.095** |
| Error | 18 | 0.000 | 0.000 | 0.005 | 0.007 | 0.008 |
| Total | 35 | | | | | |

NS= Not Significant, *= Significant at 5% level of Probability, **= Significant at 1% level of Probability.

**Appendix VIII. Mean Square Value of number and dry weight of narrow leaves weed in mungbean filed at harvest**

| Sources of variation | d. f | Smooth carbgrass (*Digitaria ischaemum*) | | Purple nutsedge (*Cyperus rotundus*) | | Jungle rice (*Echinochola colonum*) | | Bermuda grass (*Cynodon dactylon*) | | Indian goose grass (*Eleusine indica*) | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Number $m^{-2}$ | Weight $m^{-2}$ | Number $m^{-2}$ | Weight $m^{-2}$ | Number $m^{-2}$ | Weight $m^{-2}$ | Number $m^{-2}$ | Weight $m^{-2}$ | Number $m^{-2}$ | Weight $m^{-2}$ |
| Replication | 2 | 1.035 | 17.829 | 3.543 | 1.954 | 3.798 | 54.504 | 0.055 | 0.070 | 0.000 | 0.003 |
| Factor A | 2 | 8.839** | 152.561** | 30.361** | 16.663** | 32.515** | 466.752** | 0.464** | 0.592** | 0.001** | 0.027** |
| Error | 4 | 0.453 | 7.813 | 1.555 | 0.850 | 1.662 | 23.928 | 0.024 | 0.030 | 0.000 | 0.001 |
| Factor B | 3 | 22.624** | 390.472** | 77.773** | 42.644** | 83.167** | 1194.593** | 0.035** | 1.520** | 0.001** | 0.067** |
| AB | 6 | 1.287** | 74.956** | 13.987** | 5.541** | 1.057** | 115.181** | 0.014** | 0.059** | 0.001** | 0.011** |
| Error | 18 | 0.250 | 4.291 | 0.854 | 0.470 | 0.911 | 13.119 | 0.017 | 0.011 | 0.000 | 0.001 |
| Total | 35 | | | | | | | | | | |

NS= Not Significant, *= Significant at 5% level of Probability, **= Significant at 1% level of Probability.

**Appendix IX. Mean Square Value ofnumber and dry weight of broad leaf weed in mungbean filed at harvest**

| Sources of variation | d. f | Alligator weed (*Alternanthera philoxeroides*) | | Green amaranth (*Amaranthus viridis*) | | Common purslane (*Purtulaca oleracea*) | | Spreading dayflower (*Cyanotis axillaris*) | |
|---|---|---|---|---|---|---|---|---|---|
| | | Number $m^{-2}$ | Weight $m^{-2}$ | Number $m^{-2}$ | Weight $m^{-2}$ | Number $m^{-2}$ | Weight $m^{-2}$ | Number $m^{-2}$ | Weight $m^{-2}$ |
| Replication | 2 | 0.193 | 0.311 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| Factor A | 2 | 1.659** | 2.648** | 0.001** | 0.003** | 0.002** | 0.001** | 0.001** | 0.001** |
| Error | 4 | 0.085 | 0.136 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| Factor B | 3 | 4.247** | 6.791** | 0.002** | 0.007** | 0.006** | 0.002** | 0.002** | 0.001** |
| AB | 6 | 1.054** | 0.086** | 0.001** | 0.001** | 0.002** | 0.001** | 0.000** | 0.000** |
| Error | 18 | 0.047 | 0.074 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| Total | 35 | | | | | | | | |

NS= Not Significant, *= Significant at 5% level of Probability, **= Significant at 1% level of Probability.

**Appendix X. Mean Square Value of yield attributes of mungbean**

| Sources of variation | d. f | Pods plant$^{-1}$ | Pod length | Seeds pod$^{-1}$ | Weight of 1000 seeds |
|---|---|---|---|---|---|
| Replication | 2 | 0.225 | 0.027 | 0.030 | 0.015 |
| Factor A | 2 | 25.604** | 0.207 NS | 3.441** | 0.875* |
| Error | 4 | 0.046 | 0.075 | 0.006 | 0.000 |
| Factor B | 3 | 21.765** | 1.114** | 2.917** | 10.675** |
| AB | 6 | 0.342** | 0.082 NS | 0.045** | 0.000* |
| Error | 18 | 0.030 | 0.097 | 0.004 | 0.608 |
| Total | 35 | | | | |

NS= Not Significant, *= Significant at 5% level of Probability, **= Significant at 1% level of Probability.

**Appendix XI. Mean Square Value of yield of mungbean**

| Sources of variation | d. f | Seed yield | Strove yield | Biological yield | HI |
|---|---|---|---|---|---|
| Replication | 2 | 0.001 | 0.002 | 0.006 | 0.088 |
| Factor A | 2 | 0.000** | 0.103** | 0.628** | 41.229** |
| Error | 4 | 0.129 | 0.000 | 0.001 | 0.066 |
| Factor B | 3 | 0.002** | 0.139** | 0.533** | 7.926** |
| AB | 6 | 0.001** | 0.002** | 0.009** | 0.367** |
| Error | 18 | 0.000 | 0.000 | 0.001 | 0.023 |
| Total | 35 | | | | |

NS= Not Significant, *= Significant at 5% level of Probability, **= Significant at 1% level of Probability.