EFFECTS OF POTASSIUM AND SULPHUR ON THE GROWTH AND YIELD OF MUNGBEAN (BARI Mung-6)

A Thesis

By

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CERTIFICATE

This is to certify that the thesis entitled **"EFFECTS OF POTASSIUM AND SULPHUR ON THE GROWTH AND YIELD OF MUNGBEAN (BARI Mung-6)"** submitted to the DEPARTMENT OF SOIL SCIENCE, Sher-e-Bangla Agricultural University, Dhaka in partial fulfilment of the requirements for the degree of MASTER OF SCIENCE (M.S.) in SOIL SCIENCE, embodies the results of a piece of bonafide research work carried out by **SHEIKH HABIBUR RAHMAN** , Registration No. 04-01471, under my supervision and guidance. No part of this thesis has been submitted for any other degree or diploma in any other institution.

I further certify that any help or sources of information received during the course of this investigation have been duly acknowledged.

Dated: December, 2012

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DEDICATED TO

MY

BELOVED PARENTS

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EFFECTS OF POTASSIUM AND SULPHUR ON THE GROWTH AND YIELD OF MUNGBEAN (BARI Mung-6)

ABSTRACT

A field experiment was conducted at the Sher-e-Bangla Agricultural University Farm, Dhaka 1207 during the kharif season of 2012 to study the effect of potassium and sulphur on the growth and yield of Mungbean (BARI Mung-6). The experimental soil was silty clay loam in texture having pH 6.14 and organic carbon content is 0.68%. Four levels of potassium (0, 15, 25 and 35 kg K ha^{-1}) and three levels of sulphur (0, 3 and 6 kg S ha^{-1}) were used in the study. The experiment was carried out in Randomized complete block design (RCBD).There were 12 treatments combinations (four levels of K and three levels of S) and three replications. The results reveald that grain and stover yield of mungbean increased with increasing levels of potassium and sulphur.The maximum significant grain and stover yield were obtained with the treatment combinations K_2S_2 (25 kg K ha^{-1} + 6 kg S ha^{-1}) and the same treatments combinations gave the highest plant height, number of branch $plant^{-1}$, yield attributes like number of pods $plant^{-1}$, Number of grains pod^{-1}, weight of 1000 seeds. The N, P, K and S concentration of mungbean plant increased significantly from control to K_2S_2 (25 kg K ha^{-1} + 6 kg S ha^{-1}) and again decreased with increasing potassium more than 25 kg K ha^{-1}. Application of Potassium and Sulphur fertilizers increased organic carbon, N, P, K and S status of postharvest soil significantly.

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CHAPTER 1

INTRODUCTION

CHAPTER I

INTRODUCTION

Mungbean (*Vigna radiata* L.) under the family of Leguminosae is one of the most important short duration, drought tolerant pulse crop in Bangladesh. It belongs to the family Leguminosae. It is originated in Indian subcontinent . Now it is widely grown in China, Thailand, Philippines, Indonesia, Burma, Bangladesh and India. It is also grown in parts of east and central Africa, West Indies, USA and Australia. BARI Mung-6 a high yielding variety fits well in crop rotation between two cereal crops and breaks the build up of disease, insect and weed syndrome. It fixes nitrogen in symbiosis with *Rhizobia* and enriches the soil. Its root breaks the plough pan of puddled rice fields and goes deep in search of water and nutrients.

Mungbean grows well in all over Bangladesh. The production trend of mungbean in Bangladesh from the year 2006-2007 to 2009-10 was 19, 21, 18 and 20 thousand tons (area 60, 60, 54, 57 thousand ac.) respectively. During these period mungbean production has fluctuated by 5-20% (BBS, 2010). In Bangladesh the majority portion of mungbean is being produced in southern part of the country. At present the average yield of mungbean grain in our country is about 1.2 ton ha^{-1}. In Bangladesh, daily consumption of pulses is only 14.30 g $capita^{-1}$ day^{-1} (BBS, 2010), while World Health Organization (WHO) suggested 45 g $capita^{-1}$ day^{-1} for a balanced diet. In 2006-07 and 2007-08 fiscal year, 195 and 291 thousands metric ton pulses was imported in Bangladesh (BBS, 2010). But to provide the above-mentioned requirement of 45g $capita^{-1}$ day^{-1}, the production is to be increased even more than three folds.

Mungbean is used as whole or split seeds as dal (soup) but in other countries sprouted seeds are widely used as vegetables. It is considered as poor man's meat containing almost triple amount of protein as compared to rice. It has good digestibility and flavour. It contains 1-3% fat, 50.4% carbohydrates, 3.5-4.5% fibers and 4.5-5.5% ash, while calcium and phosphorus are 132 and 367 mg per 100 grams of seed, respectively (Frauque *et al.*, 2000). Hence, on the nutritional point of view, mungbean is perhaps the best of all other pulses (Khan, 1981 and Kaul, 1982). The green plants are used as animal feed and the residues as manure. The crop is potentially useful in improving cropping systems as catch crop due to its rapid growth and early maturing characteristics. As a whole, mungbean could be considered as an inevitable component of sustainable agriculture.

In general mungbean is grown in marginal lands of poor fertility and low moisture status and under poor management conditions. In spite of the many advantages of mungbean, the area coverage and the production are in declining trend (BBS, 2010). This trend is mainly due to the fact that pulses cannot compete with HYV cereals in terms of production and economic return and are thus being pushed to marginal lands where nutrient deficiencies are severe. Therefore, to meet the situation it is necessary to boost up the production through varietal development and proper management practices as well as summer mungbean cultivation. Mungbean has special importance in intensive cropping systems of the country of its short growing period. The agro-ecological conditions of Bangladesh are favourable for growing this crop. It can be cultivated both in summer and winter seasons in the country. Mungbean can tolerate a high temperature not exceeding 40°C and grows well in the temperature range of

30-35°C. It is drought tolerant and can be cultivated in areas of low rainfall. The crop is usually grown with residual moisture under rain fed condition in Bangladesh. The possibilities of growing mungbean in summer are being experimented and some successes have already been made in Bangladesh. Bangladesh Agricultural Research Institute (BARI) and Bangladesh Institute of Nuclear Agriculture (BINA) have developed a number of cultivars of mungbean.

Potassium plays a remarkable role in plant physiological processes. It is an essential constituent of different plant substances. Potassium deficiency causes yield reduction by limiting plant growth. It influences nutrient uptake by promoting root growth and nodulation. Mungbean is highly responsive to and has considerable response to potassium. Our soils are not rich in all essential nutrient elements and organic matter content. The farmers of Bangladesh generally grow mungbean with almost no . So, there is an ample scope of increasing the yield of mungbean unit^{-1} area by using balanced including potassium fertilizer. Sangakara (1990) carried out a field experiment to study the effects of 0-120 kg K_2O ha^{-1} on growth, yield parameters and seed quality of mungbean and reported that K application increased plant growth rate, flowers plant^{-1}, percent pod set seeds pod^{-1}, 1000 seed weight and yield plant^{-1}.

Sulfur plays a remarkable role in protein metabolism. It is required for the synthesis of proteins, vitamins and chlorophyll and also S containing amino acids such as methionine, cysteine, and cystine which are essential components of proteins. Lack of S causes retardation of terminal growth and root development. S deficiency induced chlorosis in young leaves and decrease seed yield by 45% (BARI, 2004).

In Bangladesh, many studies have been conducted on nutrient requirements of mungbean but reports are very few on the potassium and sulfur f requirement and on the combined effects of these elements on mungbean. Considering the above facts the present study is aimed at:

i. To determine the effects of potassium on the growth and yield of mungbean.

ii. To evaluate the effectiveness of sulfur on the growth and yield of mungbean.

iii. To study the interaction effect of potassium and sulfur on growth and yield of mungbean.

CHAPTER 2

REVIEW OF LITERATURE

CHAPTER II

REVIEW OF LITERATURE

A huge number of research works on mungbean have been performed extensively in several countries especially in the south East Asian countries for its improvement of yield and quality. In Bangladesh, little attention has so far been given for the improvement of mungbean variety or its cultural management currently the Bangladesh Agricultural Research Institute (BARI) and the Bangladesh Institute of Nuclear Agriculture (BINA) have started extensive research on varietal development and improvement of this crop. Findings of various experiments related to the present study in home and abroad have been reviewed and discussed in this chapter.

2.1 Effect of potassium on yield and yield contributing characters of mungbean

Kumer *et al.* (2012). observed that potassium application is directly related to growth, plant biomass and yield in crops. Different potassium levels significantly affected the seed yield and yield contributing parameters except number of plants per plot. Maximum seed yield (753 Kg ha^{-1}) was obtained with the application of 90 Kg potash per hectare. The interactive effect of Mungbean varieties and Potassium level was found significant in parameter of protein contents (%). Maximum protein contents were observed 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.

Abbas *et al.* (2011) observed that mineral nutrients plays a significant role in improving plant growth and development. Results showed significant impacts of applied K on plant height, number of grain pod^{-1} and grain yield as compared to control. Among different treatments, T_4 (K_2SO_4 @ 75 kg ha^{-1}) caused more prominent increase in yield and yield contributing parameters. It was concluded that K helped to improve the growth and yield of mungbean which played an important role in maintaining soil fertility.

Jahan *et al.* (2009). reported that grain and stover yield of all varieties were increased with the increase of potassium application up to 35 kg ha^{-1}. The highest grain yield (2.16 t ha^{-1}) was found at 35 kg K ha^{-1} and the lowest grain yield (1.61 t ha^{-1}) was exhibited from control potassium level and the highest stover yield (3.89 t ha^{-1}) was also found in 35 kg K ha^{-1} and the lowest (3.32 t ha^{-1}) was found in control potassium level. In case of interaction, the highest seed yield (2.58 t ha^{-1}) was produced by BARImasur-6 with 35 kg K ha^{-1}. Therefore, fertilization of all the varieties with 35 kg K ha^{-1} appeared as the best rate of potassium in respect of grain and stover yield.

Tawfik *et al.* (2008). conducted a pot experiment to study the effect of extension of irrigation interval (2, 5, and 10 days) on growth, yield and metabolic changes in mungbean (*Vigna radiata L.*) var. VC 1000 in addition to potassiomag application. Generally, fresh, dry weights and yield were significantly reduced under water stress condition. Treatment with K biofertilizer to some extent mitigated the effect of drought stress. The greatest vegetative growth was obtained in plants irrigated every two days and treated with potassium, while the greatest seed yield was obtained from plant irrigated every five days and treated with potassiomag. Osmoprotectants such as total soluble sugars, proline and glycine betaine increased in plants subjecter To water stress. It could be concluded that to maximize mungbean yield irrigation should be extended through all phenological stages, specially in flowering and pod-filling stages.

Asghar *et al.* (2006) laid out a field experiment to determine the effect of different levels of potassium (0, 25,50,75 and 100 kg ha^{-1}) on growth, yield and quality of two mungbean genotypes (NM-92 and NM-98) was studied in the Department of Agronomy, University of Agriculture, Faisalabad during 2003. Different potassium levels significantly affected the seed yield and Protein contents. Maximum seed yield (1458.46 kg ha^{-1}) with 25.31 percent in contents was obtained with 100 kg K per hectare. Genotype NM-98 produced higher seed yield than NM-92.

Oad and Buriro (2005) laid out a field experiment to determine the effect of different NPK levels on the growth and yield of mung bean *cv. AEM 96* and showed that the 10-30-30 kg N-P-K $ha^{-1}$was the best treatment, recording plan height of 56.25 cm, pod length of 5.02 cm, seed weight per plant of 10.53 g and the highest seed yield of 1205.2 kg ha^{-1}.

Ahmad *et al.* (2003) conducted an experiment on mungbean with N P K at 50 : 0: 0 (F_1), 50 : 100 : 0 (F_2) and 50 : 100 : 50 kg ha^{-1}. (F_3) and revealed that no significant differences in the number of pods per plant, number of grains per plant, grain yield and straw yield were observed in plants under F_2 and $F_{3,}$ F: resulted in the highest grain yield value and costs, and lowest net field benefit.

Abraham and Lal (2003) conducted field experiments from 1997 to 1999 to investigate the effects of NPK fertilizer, organic manures (farm compost + vermicompost and farm compost + poultry manure) and bio on the productivity of black gram-wheat-greengram cropping system black gram and green gram and grain yield for wheat were highest with farm grain yield compost + poultry manure, but the highest seed yield was recorded with farm compost + vermicompost in black gram in the first year. The treatment biofertilizer + cow's urine recorded higher values of pod count in the first year and weight and seed yield in the second year in green gram.

Oad *et al.* (2003) conducted a field experiment on the growth and yield performance of mungbean (*Vigna radiata*) and showed that mungbean varieties were significantly influenced by phosphorus and potassium except pod number, seed weight per plant and seed index were non-significant. However, 100 kg P and 100 kg K ha^{-1} showed an increase in the yield of the crop.

Chanda *et al.* (2002) carried out a field experiment on mungbean and showed that seed yield, protein content and net production value increased with increasing rates of K and S similarly, the status of N and P in soil decreased with increasing rates of K and S.

Das *et al.* (2002) studied the effects of vermicompost and chemical fertilizer application on the growth and yield of green gram (*V. radiata cv. Sujata*). The dry matter and pod yield of green gram were increased with the application of vermicompost applied in integrated form. The yield was highest with 100% enriched vermicompost compared to sole organic manure. Greater dry matter content, pod yield, nutrient uptake (N, P and K), plant height, leaf area, root volume, number of nodules and fresh weight of nodules were obtained with treatments containing vermicompost. Flowering was earlier by 7 days in vermicompost treated plants compared with the control.

Sangakara *et al.* (2001) carried out a field experiment to determine the benefits of potassium in overcoming water stress in mungbean. They found that potassium increased the shoot growth, root growth and as a significant factor in overcoming soil moisture stress in tropical cropping systems.

Prasad *et al.* (2000) conducted a pot experiment to study the effects of potassium on yield, water use efficiency and K-uptake by summer mungbean. They observed that total biomass production, grain yield, the water use efficiency and potassium uptake significantly increased with 20 and 30 kg K as compared to other levels of potassium.

Gobindar and Thirumurugan (2000) conducted an experiment and observed that 1.0% KCI + 1.0% $KN0_3$ gave the highest values for plant height at harvest (48.6 cm), leaf area index at 60 DAS (6.83), number of branches plant^{-1} (2.89), number of pods plant^{-1} (20.6), pod length (8.12cm), number of grains pod^{-1} (10.77), 100-grain weight (4.0 g), gain yield (777 kg ha^{-1}), dry

matter production at harvest (2783 kg ha^{-1}) and benefit : cost (2.53).

Ram and Dixit (2000) conducted a field experiment on summer greengram cv. k-851 and revealed that nodulation, N, P and K uptake and yield increased with increasing P rate.

Chaudhury and Mahmood (1999) laid out a field experiment to study the effect of optimum potassium levels on growth, yield and quality of mungbean and reported that 50 kg K_2O gave the highest seed yield (832 kg ha^{-1}) and also reported that the optimum level of $K_2O$was between 50 to 100 kg per hectare.

Reddy *et al.*(1998) carried out a field trial during kharif of 1995 at Attibele, Karnataka, India, on peas cv. Selection FC-1 with 0, 50 or 100% of the recommended rates of NPK (37.5: 60 : 50 kg ha^{-1}), and 0, 5 or 10 t farmyard manure and/or vermicompost ha^{-1}. Plant height at harvest, days to initial flowering, number of branches per plant, number of pods per plant, number of seeds per pod and yield were highest with 10 t vermicompost + 100% recommended NPK.

Sushil *et al.* (1997) conducted an experiment to study the effect of sulphur, potassium and phosphorus supply (0, 25, 50 and 100 mM) on seed protein of *Vigna radiata*. They reported that the amount of globulin and albumin were increased with increasing concentrations of K. Tryptophan in all the protein fractions also increased with higher K levels.

Chatterjee and Mandal (1996) carried out a field experiment on integrated fertilizer management with or without application of potassium and organic matter or manure. They observed that maximum crop productivity was achieved using 150% of the recommended doses of N, P and K in rice-potato-sesame, rice-potato-mungbean and rice-potato-groundnut systems and the available K status was improved in 0-15 cm soil depth.

Abd-El-Lateef *et al.* (1998) carried out a field experiment with 0, 15.5 or 31 kg P_2O_5 and 0 or 24 kg K_2O $feddan^{-1}$ and observed that seed yield increased by the application of K and the lower rates of P (1 feddan = 0.42ha).

Singh *et al.* (1993) found significant increase of nitrogen concentration in mungbean due to the application of increasing level of K fertilizer.

Sangakkara, U. R. (1990) observed in an experiment that K application increased plant growth rate, flowers plant^{-1}, percentage pod set, seeds pod^{-1}, 100-seed wt and yield plant^{-1}. In the short maturing cv. MI 5, seed yield and quality increased with a basal application of up to 80 kg K ha^{-1} and a split application of up to 60 kg K ha^{-1}. In the long maturing cv. Type 61, seed yield and quality increased with a basal application of up to 100 kg K ha^{-1}or a split application of up to 80 kg K ha^{-1}.

Maiti *et al.* (1988) reported that 60 or 100 kg ha^{-1} each of P_2O_5 and K_2O increased seed yield in *Vigna radiata* and lentils.

Sardana and Verma (1987) made a field trial in Delhi, India with combined application of aldicarb (for the control of various insect pests) with nitrogen, phosphorus and potassium and reported that plant height, leaf surface area, number and length of pods, 100-grain weight and yield of green gram were significantly increased.

2.2 Effect of S on yield and yield attributing characters of mungbean

Tripathi *et al.* (2012) reported that application of 45 kg S ha^{-1} recorded higher plant height, primary branches, green trifoliates, leaf area index, dry matter accumulation, nodule numbers and nodule dry weight, increased days to maturity, number of pod and higher grain and straw yield as compared to cultivars Pusa Vishal and SML-668, and S application at 15 and 30 kg ha^{-1} , respectively. Nodule number was highest in 45 kg S ha^{-1} in Pusa Vishal and HUM-1. Maximum dry matter recorded with 45 kg S ha^{-1}.

Kumar *et al.* (2012). reported that increasing levels of phosphorus and sulphur enhanced the growth, plant height, yield attributes like number of nodules $plant^{-1}$, dry weight of nodules, number of pods $plant^{-1}$, number of grains pod^{-1}, 1000-grain weight, grain yield, and straw yield showed maximum increase at 45 kg P_2O_5 ha^{-1} and 30 kg S ha^{-1}, respectively. The increase in grain and straw yield with successive increase in phosphorus and sulphur levels, was more at 30 kg S ha^{-1} and 45 kg P_2O_5 kg ha^{-1}. Overall the difference between 20 kg and 30 kg S $ha^{-1}$was not differed significantly. But the growth characters yield attributes and yield of mungbean response significantly the highest level of phosphorus i.e. 45 kg P_2O_5 ha^{-1}.

Shah *et al.* (2011) observed that number and weight of nodules, grain and straw yield, content of P and S were increased with increase in level of P and S individually as well as in various combinations. Applied P and S increased grain nitrogen and protein contents. Available P in soil was increased with increasing levels of phosphorus. Similarly available S in soil was increased with increasing levels of sulphur. The synergistic effect of phosphorus and sulphur was reported on number and weight of nodules $plant^{-1}$, N, P, S and protein content of clusterbean.

Jahan *et al.* (2009). reported that sulphur (S) requirement of plants has become increasingly importance in India as well as world agriculture. However, to achieve high yields and rates of S fertilizer should be recommended on the basis of available soil S and crop requirement.

Islam *et al.* (2009). observed that application of P and S resulted in significant increase in grain yield ranging from 22 to 35% and 10 to 16% over control, respectively. Effect of P and S application was synergistic and antagonistic at higher level of P (80 kg ha^{-1}). Lower level of P application (40 kg ha^{-1}) resulted in increase in zinc (Zn) uptake by 23 to 25% over control and higher rate (80 kg ha^{-1}) caused decline in Zn uptake. Almost similar observations were recorded regarding the effect of S application on Zn uptake in both grain and straw.

Singh *et al.* (1997) conducted a field experiment to study the effect of S and Zn on summer green gram (*Vigna radiata*). They reported that application of 30 kg S and 5 kg Zn ha^{-1} were optimum for plant height, dry matter accumulation, seed protein, yield and S and Zn uptake. Summer Mungbean (*Vigna radiata*) was grown in the field for two years with the application of elemental S (0, 15, 30 and. 45 kg ha^{-1}) in an Inceptisol. Sulphur application significantly improved plant biomass, nodule number and seed weight of mungbean optimum being 30 kg ha^{-1}.

Tripathi *et al.* (1997) conducted a field experiment consisting of 4 levels of S and Zn. They reported that application of S and Zn had conspicuous and significant effect on yield attributes i.e. number of seeds $plant^{-1}$ 1000-grain weight, grain and straw yield of greengram. These characters increased significantly with an increase in S and Zn doses upto 40 kg S ha -l and 5 kg Zn ha^{-1}) and thereafter decreased at 60 kg S ha^{-1}.

Singh *et al.* (1997) found significant increase in stover yield of mungbean due to the application of S.

Singh *el al.* (1993) found significant increase of phosphorus concentration in soil mungbean field due to the application of K (30, 60, and 90 kg K_2O ha^{-1}) and S (5,10 and 15 ppm).

2.3 Interaction effect of K and S on yield and yield attributing characters of mungbean

Duary *et al.* (2004)conducted a study on green gram and showed that Rhizobium, 10 kg N ha^{-1}, 30 kg P ha^{-1}, 30 kg K ha^{-1}, 20 kg S ha^{-1} produced the significantly highest seed yield.

Bandopadhyay *et at.* (2002) reported that the number of pod $plant^{-1}$, kernel, oil yield of groundnut increased due to application of S with P, K, Zn and B.

Nita *et al.* (2002) carried out a field experiment in West Bengal, India during the summer of 1998-99 to study the effect of K and S at 0, 20 and 40 kg ha^{-1}, applied singly or in combination on the growth and productive attributes of mungbean. They reported that leaf area index, plant height, nodules $plant^{-1}$, nodule dry weight, pods $plant^{-1}$, 1000-seed yield, grain yield, harvest index and N, P, K and S contents in seeds and stover of mungbean were increased with increasing rates of K and S.

Kaushik *et al.* (1996) observed that in a greenhouse experiment, *Vigna radiata cv.* CS-94 was given 0-120 mg S ha-1 as pyrite or elemental S (3 weeks of sowing) or gypsum or K_2SO_4 (at sowing). They observed that leaf and stem dry matter, yield and N and P contents increased with upto 40 mg S irrespective of source, where as K content increased with upto 80 mg S.

CHAPTER 3

MATERIALS AND METHODS

CHAPTER III

MATERIALS AND METHODS

This chapter includes a brief description of the experimental soil, mungbean variety, land preparation, experimental design, treatments, cultural operations, collection of soil and plant samples etc. and analytical methods followed in the experiment to study the effect of potassium and sulphur on the yield of mungbean.

3.1 Experimental site

The research work relating to the study of the effect of potassium and sulphur on the yield of mungbean was conducted at the Sher-e-Bangla Agricultural University Farm, Dhaka- 1207 during the *Kharif* season of 2012.

3.2 Description of soil

The soil of the experimental field belongs to the Tejgaon series under the Agro ecological Zone, Madhupur Tract (AEZ- 28) and the General Soil Type is Deep Red Brown Terrace Soils in Table 3.1.

Table 3.1 Morphological Characteristics of experimental field

Morphological Features	Characteristics
Location	Sher-e-Bangla Agricultural University Farm, Dhaka
AEZ No. and name	AEZ-28, Modhupur Tract
General Soil Type	Deep Red Brown Terrace Soil
Soil Series	Tejgaon
Topography	Fairly leveled
Depth of inundation	Above flood level
Drainage condition	Well drained
Land type	High land

Table 3.2 Physical and chemical properties of the initial soil of the experimental field

Soil properties	Value
A. Physical Properties	
1. Particle size analysis of soil	
% Sand	33.21
% Silt	40.51
%Clay	26.28
2. Soil texture	Loam
B. Chemical Properties	
1. Soil pH	5.71
2. Organic carbon (%)	0.68
3. Organic matter (%)	1.17
4. Total N (%)	0.0533
5.C:N ratio	9.75 : 1
6. Available P ($mgkg^{-1}$)	21.54
7. Available K (meq/100g soil)	0.145
8. Available S ($mgkg^{-1}$)	15.08
9. Available Zn ($mgkg^{-1}$)	1.822

3.3 Description of the mungbean variety

BARI Mung-6, a high yielding variety of mungbean was released by Bangladesh Agricultural Research Institute, Joydebpur, Gazipur in 2003. It is photo insensitive, semi synchronous maturity, short lifespan (60 to 65 days) and bold seeded crop. Its yield potentiality is about 2 t ha^{-1}. This variety is resistant to yellow mosaic virus diseases, insects and pest attack.

3.4 Climate

The experimental area has sub-tropical climate characterized by heavy rainfall during May to September and scanty rainfall during rest of the year. The annual precipitation of the site is 2052 mm and potential evapotranspiration is 1286mm, the average maximum temperature is 30.35^0C and average minimum temperature is 21.14^0C. The average mean temperature is 25.12^0C (BBS, 2010). The experiment was carried out during kharif season, 2012.

3.5 Preparation of the field

The plot selected for the experiment was opened by power tiller driven rotovator on the 10^{th} April 2012; afterwards the land was ploughed and cross-ploughed several times followed by laddering to obtain a good tilth. Weeds and stubbles were removed and the large clods were broken into smaller pieces to obtain a desirable tilth of soil for sowing of seeds. Finally, the land was leveled and the experimental plot was partitioned into the unit plots in accordance with the experimental design mentioned in the following section.

3.6 Layout of the experiment

The experiment was laid out in a Randomized Complete Block Design with three replications. The total number of plots was 36, each measuring 2.5 m x 2 m (5 m^2). The treatment combination of the experiment was assigned at random into 12 plots of each at 3 replications. The distance maintained between two plots was 75 cm and between blocks was 100 cm. The layout of the experiment is presented in appendix 3.

3.7 Treatments

The experiment consists of 2 factors i.e. potassium and sulphur . Details of factors and their combinations are presented below:

Factor A: Potassum (K)

1. $K_0 = 0$ kg K ha^{-1}
2. $K_1 = 15$ kg K ha^{-1}
3. $K_2 = 25$ kg K ha^{-1}
4. $K_3 = 35$ kg K ha^{-1}

Factor B : Sulfur (S)

1. $S_0 = 0$ kg S ha^{-1}
2. $S_1 = 3$ kg S ha^{-1}
3. $S_2 = 6$ kg S ha^{-1}

Treatment combinations:

1. K_0S_0 = Control (No K and S)
2. K_0S_1 = 0 kg K ha^{-1}+ 3 kg S ha^{-1}
3. K_0S_2 = 0 kg K ha^{-1}+ 6 kg S ha^{-1}
4. K_1S_0 = 15 kg K ha^{-1}+ 0 kg S ha^{-1}
5. K_1S_1 = 15 kg K ha^{-1}+ 3 kg S ha^{-1}
6. K_1S_2 = 15 kg K ha^{-1}+ 6 kg S ha^{-1}
7. K_2S_0 = 25 kg K ha^{-1}+ 0 kg S ha^{-1}
8. K_2S_1 = 25 kg K ha^{-1}+ 3 kg S ha^{-1}
9. K_2S_2 = 25 kg K ha^{-1}+ 6 kg S ha^{-1}
10. K_3S_0 = 35 kg K ha^{-1}+ 0 kg S ha^{-1}
11. K_3S_1 = 35 kg K ha^{-1}+ 3 kg S ha^{-1}
12. K_3S_2 = 35 kg K ha^{-1}+ 6 kg S ha^{-1}

3.8 Application of

The required amounts of K and S from muriate of potash and gypsum were applied at the time of final land preparation as per treatment combinations and design of the experiment. Phosphorus fertilizer at the rate of 80 kg TSP ha^{-1} and nitrogen fertilizer as half urea was applied at final land preparation. The rest of half urea was applied 25 days after sowing (DAS). The were then mixed well with the soil by spading and individual unit plots were leveled.

3.9 Seed sowing

Mungbean seeds were sown on 18th April, 2012 in lines following the recommended line to line distance of 30 cm and plant to plant distance of 10 cm.

3.10 Cultural and management practices

Various intercultural operations such as thinning of plants, weeding and spraying of insecticides were accomplished whenever required to keep the plants healthy and the field weed free. At the very early growth stage (after 15 days of emergence of seedlings) the plants were attacked by cutworm, which was removed by applying malathion. Special care was taken to protect the crop from birds especially after sowing and germination stages. The field was irrigated twice- one at 15 days and the other one at 30 days after sowing.

3.11 Harvesting

The crop was harvested at maturity on 20th June, 2012. The harvested crop of each plot was bundled separately. Grain and straw yields were recorded plot wise and the yields were expressed in t ha^{-1}.

3.12 Collection of samples

3.12.1 Soil Sample

The initial soil samples were collected randomly from different spots of the field selected for the experiment at 0-15 cm depth before the land preparation and mixed thoroughly to make a composite sample for analysis. Post harvest soil samples were collected from each plot at 0-15 cm depth on 24^{th} June 2012. The samples were air-dried, grounded and sieved through a 2 mm (10 meshes) sieve and preserved separately for analysis.

3.12.2 Plant sample

Plant samples were collected from every individual plot for laboratory analysis at maturity stage of the crop. The samples were collected by avoiding the border area of the plots. The plant samples were dried in the electric oven at 70^0 C for 48 hours. After that the samples were ground in an electric grinding machine and stored for chemical analysis.

3.13 Collection of experimental data

Ten (10) plants from each plot were selected as random and were tagged for the data collection. Data were collected at harvesting stage. The sample plants were cut down to ground level prior to harvest and dried properly in the sun. The seed yield and stover yield per plot were recorded after cleaning and drying those properly in the sun. Data were collected on the following parameters:

1. Plant height (cm)
2. Number of branches plant^{-1}
3. Number of pods plant^{-1}
4. Pod length (cm)

5. Number of seeds pod^{-1}

6. Weight of 1000-seeds (g)

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

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

9. N, P, K and S content of plant

10.N P, K and S contents in seed

11. N, P, K and S contents in postharvest soil

3.13.1 Plant height

The plant height was measured from the ground level to the top of the canopy of 10 randomly selected plants from each plot and averaged. It was done at the maturity stage of the crop.

3.13.2 Number of branches plant^{-1}

No. of branches were counted from 10 randomly selected plants at maturity stage from each plot and averaged.

3.13.3 Number of pods plant^{-1}

Pods of 10 randomly selected plants were counted at maturity stage from each plot and averaged.

3.13.4 Pod length (cm)

Pod length was measured at maturity stage for l0 pods randomly collected from each plot and averaged.

3.13.5 Number of seeds pod^{-1}

The number of seeds from 10 randomly selected pods from each plot were counted and averaged.

3.13.6 Thousand seed weight

Thousand seeds of mungbean were counted randomly and then weighed plot wise.

3.13.7 Grain yield

Grains obtained from 1 m^2 area from the center of each individual plot was dried, weighed carefully and then converted into t ha^{-1} as yield.

3.13.8 Stover yield

Stover obtained from 1 m^2 area from the center of each individual plot was dried, weighed carefully and expressed in t ha^{-1}.

3.14 Chemical analysis of the plant and soil samples

3.14.1 Plant sample analysis

The ground plant samples were digested with conc. HNO_3 and $HClO_4$ mixture for the determination of P, K and S.

3.14.1. a Nitrogen

Plant samples were digested with 30% H_2O_2, conc. H_2SO_4 and a catalyst mixture (K_2SO_4 : $CuSO_4.5H_2O$: Selenium powder in the ratio 100 : 10 : 1, respectively) for the determination of total nitrogen by Micro-Kjeldal method. Nitrogen in the digests were determined by distillation with 40% NaOH followed by titration of the distillate absorbed in H_3BO_3 with 0.01N H_2SO_4 (Jackson, 1973).

3.14.1. b Phosphorous

Phosphorous in the digest was determined by ascorbic acid blue color method (Murphy and Riley, 1962) with the help of a spectrophotometer.

3.14.1.c Potassium

The exchangeable potassium content in plant samples were determined by flame photometer (Black, 1965).

3.14.1.d Sulphur

Sulphur content in the digests were determined by turbidimetric method as described by Hunt (1980) using a spectrophotometer (LKB Novaspac, 4049).

3.14.2 Soil sample analysis

3.14.2. a Total nitrogen

Total nitrogen of soil samples were estimated by Micro-Kjeldahl method where soils were digested with 30% H_2O_2 conc. H_2SO_4 and catalyst mixture (K_2SO_4: $CuSO_4$. 5 H_2O : Selenium powder in the ratio 100 : 10 : 1). Nitrogen in the digests were determined by distillation with 40% NaOH followed by titration of the distillate absorbed in H_3BO_3 with 0.01N H_2SO_4 (Jackson, 1973).

3.14.2. b Available Phosphorous

Available phosphorous was extracted from the soil by Bray-1 method (Bray and Kurtz, 1945). Phosphorous in the extract was determined by ascorbic acid blue color method (Murphy and Riley, 1962) with the help of a spectrophotometer.

3.14.2. c Available Potassium

Available potassium was extracted from soil by 1N ammonium acetate. The exchangeable potassium content in plant samples were determined by flame photometer (Black, 1965).

3.14.2.d Available sulphur

Available sulphur was extracted from the soil with Ca $(H_2PO_4)_2.H_2O$. Sulphur in the extract was determined by the turbidimetric method as described by Hunt (1980) using a Spectrophotometer (LKB Novaspec, 4049). The intensity of turbid was measured by spectrophotometer at 420 nm wavelength.

3.14.3 Statistical analysis

The data were analyzed using MSTAT-C to find out the significance of the difference among the treatments, The mean values of all the characters were evaluated and analysis of variance was performed by the 'F' (variance ratio) test. The significance of the differences among pairs of treatment means was estimated by the Least Significant Difference (LSD) test at 5% and 1% level of probability (Gomez and Gomez, 1984).

CHAPTER 4

RESULTS DISCUSSION

CHAPTER IV

RESULTS AND DISCUSSION

The results on different yield attributes, yield and nutrient concentrations in the plants and, grains and availability of different nutrients in the soil after harvest of mungbean are presented in this chapter.

4.1 Effects of Potassium on growth and yield of mungbean

4.1.1 Effect of potassium on plant height

The effects of potassium on the plant height of mungbean are presented in (Table 4.1). Significant variation was observed on plant height when the plot was fertilized with different doses of potassium. Plant height was increased with K levels from 0-25 kg ha^{-1} then declined. The highest plant height (52.00 cm) was obtained with 25 kg K ha^{-1} which was significantly higher than all other treatments. The second highest plant height was recorded in K_3 treatment. On the other hand, the lowest plant height (41.68 cm) was observed in the K_0 treatment where no potassium was applied. The result is agreed with the findings of Abbas *et al.* (2011) who observed significant increase in plant height of mungbean due to the application of increasing level of K fertilizer

Table 4.1 Effect of potassium on growth parameters

Treatments	Plant height (cm)	No. of branches plant^{-1}	No. of pods plant^{-1}	Pod length (cm)
K_0	41.68 d	1.67 d	14.70 c	6.60 d
K_1	46.39 c	2.22 c	16.91 b	7.64 c
K_2	52.00 a	2.66 a	19.52 a	9.51 a
K_3	49.89 b	2.45 b	17.64 b	8.89 b
$LSD_{(0.05)}$	0.9830	0.119	1.123	0.579
CV (%)	1.22	2.98	3.86	4.18

In a column figures having similar letter(s) do not differ significantly whereas figures with dissimilar letter(s) differ significantly.

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4.1.2 Effect of potassium on number of branches plant^{-1}

Significant variation was observed in number of branches plant^{-1} of mungbean when different doses of potassium were applied (Table 4.1). The highest number of branches plant^{-1} (2.66) was recorded in K_2 (25 kg K ha^{-1}). The lowest number of branches plant^{-1} (1.67) was recorded in the K_o plot. Abbas *et al.*(2011) found significant increases in number of branches of mungbean with successive increase in K_2SO_4 levels at 75 kg ha^{-1}.

4.1.3 Effect of potassium on number of pods plant^{-1}

Different doses of potassium showed significant variation in respect of number of pods plant^{-1} of mungbean when different doses of potassium were applied (Table 4.1). The highest number of pods plant^{-1} (19.52) was recorded in K_2 (20 kg K ha^{-1}). The lowest number of pods plant^{-1} (14.70) was recorded in the K_0 treatment where no potassium was applied. Abbas *et al.* (2011) found significant increase in number of pods plant^{-1} of mungbean.

4.1.4 Effect of potassium on pod length

Pod length as affected by different doses of potassium showed a statistically significant variation (Table 4.1). Among the different doses of K the highest pod length (9.51 cm) was observed in K_2 (25 kg K ha^{-1}) and the lowest pod length (6.60 cm) was recorded in the K_0 treatment where no K was applied. Abbas *et al.*(2011) found significant increase on pod length of mungbean with successive increase in K_2SO_4 levels at 75 kg ha^{-1}.

4.1.5 Effect of potassium on number of seeds pod^{-1}

Potassium had significant variation on number of seeds pod^{-1} of mungbean when different doses of potassium were applied (Table 4.2). The highest number of seeds pod^{-1} (11.93) was recorded in K_2 (25 kg K ha^{-1}). The lowest number of seeds pod^{-1} (9.179) was recorded in the K_0 treatment where potassium was applied.

Table 4.2 Effect of potassium on yield and yield contributing characters

Treatments	No. of seeds pod^{-1}	1000-seed wt. (gm)	Grain yield (t ha^{-1}) (t ha^{-1})	Stover yield (t ha^{-1})
K_0	9.17 c	39.89 c	1.113 c	2.067 c
K_1	10.50 b	42.00 b	1.273 b	2.230 b
K_2	11.93 a	43.87 a	1.597 a	2.451 a
K_3	10.84 b	43.30 a	1.552 a	2.475 a
$LSD_{(0.05)}$	0.571	0.8330	0.05355	0.07573
CV (%)	3.18	1.16	2.49	1.97

In a column figures having similar letter(s) do not differ significantly whereas figures with dissimilar letter(s) differ significantly.

4.1.6 Effect of potassium on weight of 1000-seed

Significant variation was observed on the weight of 1000 seed of mungbean when different doses of K were applied (Table 4.2). The maximum weight of 1000-seed (43.87 g) was found in K_2 (25 kg K ha^{-1}) which was similar to the treatment K_3. The lowest weight of 1000-seed (39.89 g) was recorded in the K_0 treatment where no K was applied. Sangakara (1990) found the similar results.

4.1.7 Effect of K on grain yield

Different doses of K caused significant variation on the grain yield of mungbean (Table 4.2). The highest grain yield of mungbean (1.597 t ha^{-1}) was recorded in K_2 (25 kg K ha^{-1}) which was statistically similar with the K_3 treatment. The lowest grain yield of mungbean (1.113 t ha^{-1}) was recorded in the K_0 treatment where no K was applied. These findings are similar with some other researcher's findings, Jahan *et al.* (2009) who obtained highest mungbean grain yield due to the application of 35 kg K ha^{-1}

4.1.8 Effect of K on stover yield

Different doses of K caused significant variation on the stover yield of mungbean (Table 4.2). The highest stover yield of mungbean (2.475 t ha^{-1}) was recorded in K_3 (35 kg K ha^{-1}) which was statistically similar with the K_3 treatment. The lowest stover yield (2.067 t ha^{-1}) was recorded in the K_0 treatment where no K was applied. The present result was in agreement with that of Jahan *et al.* (2009).

4. 2 Effects of Sulphur on growth and yield of mungbean

4.2.1 Effect of Sulphur on plant height

Mungbean plants showed significant variation in plant height when sulphur in different doses were applied (Table 4.3). Among the different doses, S_2 (6 kg S ha^{-1}) showed the highest plant height (48.84 cm). On the contrary, the lowest plant height (46.16cm) was observed in the treatment where no sulphur was applied. The findings of Kumar *et al.* (2012) were in agreement with these results.

4.2.2 Effect of sulphur on number of branches $plant^{-1}$

Different doses of S showed significant variations in respect of number of branches $plant^{-1}$ (Table 4.3). Among the different doses, S_2 (6 kg S ha^{-1}) showed the highest number of branches $plant^{-1}$ (2.437). On the contrary, the lowest number of branches $plant^{-1}$ (2.055) was observed with S_0, where no sulphur was applied. The result accords with the findings of Tripathi *et al.* (2012) who observed significant increase in number of branches $plant^{-1}$ of mungbean due to the application at 45 kg S ha^{-1}.

Table 4.3 Effect of sulphur on growth parameters

Treatments	Plant height (cm)	No. of branches $plant^{-1}$	No. of pods $plant^{-1}$	Pod Length (cm)
S_0	46.16 c	2.05 c	16.12 b	7.41 c
S_1	47.46 b	2.27 b	17.06 b	8.22 b
S_2	48.84 a	2.43 a	18.40 a	8.85 a
$LSD_{(0.05)}$	0.9830	0.119	1.123	0.579
CV (%)	1.22	2.98	3.86	4.18

In a column figures having similar letter(s) do not differ significantly whereas figures with dissimilar letter(s) differ significantly.

4.2.3 Effect of sulphur on number of pods plant^{-1}

Different doses of sulphur showed insignificant variations in respect of number of pods plant^{-1} (Table 4.3). Among the different doses S_2 (6 kg S ha^{-1}) produced the highest number of pods plant^{-1} (18.40). On the other hand S_0 and S_1 has no significant difference. This findings is inconformity with the results of Tripathi *et al.* (2012) who observed significant increase in number of pods plant^{-1} of mungbean due to the application at 45 kg S ha^{-1}.

4.2.4 Effect of sulphur on Pod length

Application of sulphur at different doses showed a significant variation on the pod length of mungbean (Table 4.3). Among the different S fertilizer doses, S_2 (6 kg S ha^{-1}) showed the highest pod length (8.85 cm) where do the treatment S_0 showed the lowest (7.41 cm). Singh and Yadav (1997) stated that the increased level of sulphur increased the pod length of mungbean.

4.2.5 Effect of sulphur on number of seeds pod^{-1}

There was significant variation in respect of number of seeds pod^{-1} due to the application of S (Table 4.4). Among the different doses of S_2 showed the highest number of seeds pod^{-1} (11.26) which was statistically similar with the S_1 doses of sulphur applied.

Table 4.4 Effect of sulphur fertilizer on yield and yield contributing characters and the yield

Treatments	No. of seeds pod-1	1000-seed wt (gm)	Grain yield (t ha^{-1})	Stover yield (t ha^{-1})
S_0	9.80 b	40.83 c	1.266 c	2.208 b
S_1	10.77 a	42.31 b	1.325b	2.282 b
S_2	11.26 a	43.65 a	1.511 a	2.427 a
$LSD_{(0.05)}$	0.571	0.8330	0.05355	0.07573
CV (%)	3.18	1.16	2.49	1.97

In a column figures having similar letter(s) do not differ significantly whereas figures with dissimilar letter(s) differ significantly.

4.2.6 Effect of sulphur on weight of 1000-seed

Different doses of sulphur showed significant variations in respect of the weight of 1000-seed (Table 4.4). Sulphur at S_2 (3 kg S ha^{-1}) produced the highest weight of 1000-seed (43.65 g). On the contrary, the lowest weight of 1000-seed (40.83 g) was observed with S_2 where no S was applied. Islam *et al.* (2009) found significant increase in weight of 1000- seed of mungbean due to the application of increasing level of S.

4.2.7 Effect of sulphur on grain yield

Significant variations in grain yield of mungbean was observed due to application of different doses of sulphur (Table 4.4). Among the different doses of S, S_2 (6 kg S ha^{-1}) produced the highest grain yield of mungbean (1.511 t ha^{-1}) and the lowest grain yield (1.266 t ha^{-1}) was found in S_0 where no S was applied. Similar results were obtained by Islam *et al.* (2009).

4.2.8 Effect of S on stover yield

Different doses of S had significant effects on the stover yield of mungbean (Table 4.4). Application of S at 6 kg S produced the highest stover yield (2.427 t ha^{-1}) and so treatment showed the lowest. The results are in agreement with the findings of Singh *et al.* (1997) and in which they found significant increases in stover yield of mungbean due to the application of S.

4. 3 Effects of potassium and sulphur on growth and yield of mungbean

4.3.1 Interaction effect of potassium and sulphur on plant height

Combined application of different doses of potassium and sulphur showed significant effect on the plant height of mungbean (Fig. 4.1). The highest plant height (54.38 cm) was recorded with $K_2 S_2$ (25 kg K ha^{-1} + 6 kg S ha^{-1}) which was statistically superior to other treatments.The lowest plant height (39.90 cm) was observed in the treatment combination of K_0S_0 (No potassium and No sulphur). Bandopadhyay *et al.* (2002) found significant increase in plant height of mungbean due to the application of increasing level of K and S.

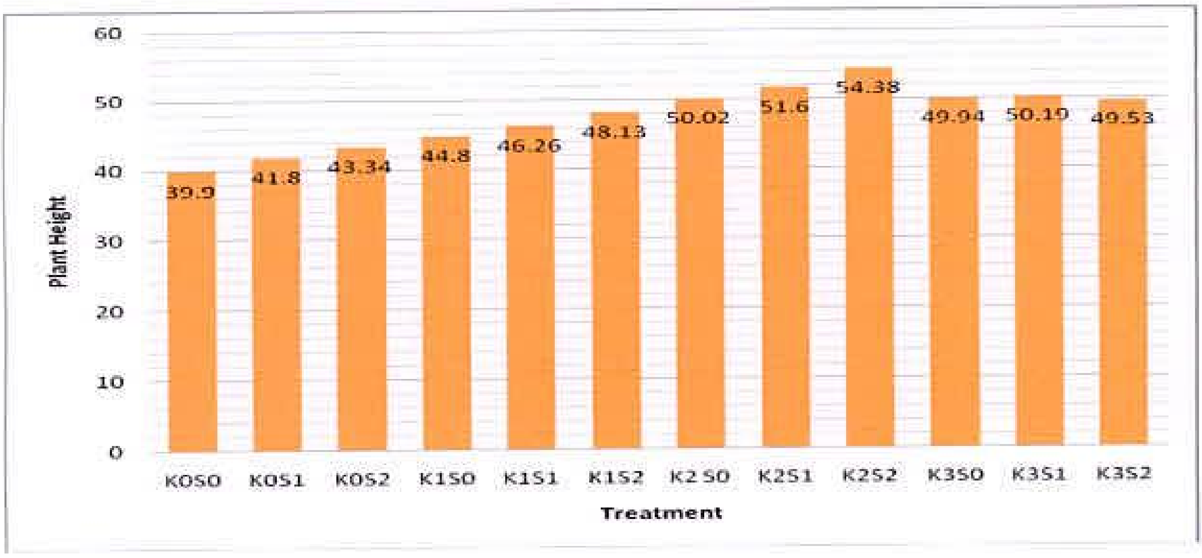

Fig. 4.1: Interaction effect of potassium and sulphur on plant height

4.3.2 Interaction effect of potassium and sulphur on number of branches plant^{-1}.

The combined effect of different doses of K and S had significant role on the number of branches plant^{-1} of mungbean (Table 4.5). The highest number of branches plant^{-1} (2.90) was recorded with the treatment combination of K_2S_2 (25 kg K ha^{-1} + 6 kg S ha^{-1}) and the lowest number of branches plant^{-1} (1.540) was found in control treatment (No K and No S). Bandopadhyay *et al.* (2002) found significant increase in number of branches plant^{-1} of mungbean due to the application of increasing level of K and S.

Table 4.5 Interaction effect of potassium and sulphur on growth parameters

Treatments	No. of branches plant^{-1}	No. of pods plant^{-1}	Pod Length (cm)
K_0S_0	1.54 h	14.05 h	6.05 g
K_0S_1	1.62 h	14.64 gh	6.69 f
K_0S_2	1.86 g	15.41 g	7.07 f
K_1S_0	2.04 f	15.57 fg	7.21 f
K_1S_1	2.25 e	16.62 ef	7.30 f
K_1S_2	2.36 de	18.53 bc	8.42 de
K_2S_0	2.34 de	17.84 cd	7.92 e
K_2S_1	2.75 b	19.53 b	10.01 b
K_2S_2	2.90 a	21.20 a	10.61 a
K_3S_0	2.29 e	17.01 de	8.47 de
K_3S_1	2.45 d	17.46 cde	8.89 cd
K_3S_2	2.61 c	18.45 bc	9.30 c
$LSD_{(0.05)}$	0.119	1.123	0.579
CV (%)	2.98	3.86	4.18

In a column figures having similar letter(s) do not differ significantly whereas figures with dissimilar letter(s) differ significantly.

4.3.3 Interaction effect of potassium and sulphur on number of pods plant^{-1}

The interaction effects of different doses of potassium and sulphur on number of pods plant^{-1}of mungbean was significant (Table 4.5). The highest number of pods plant^{-1} (21.20) was found with the treatment combination of K_2S_2 (25 kg K ha^{-1} + 6 kg S ha^{-1}) and the lowest number of pods plant^{-1} (14.05) was found in K_0S_0 (0 kg K ha^{-1} + 0 kg S ha^{-1}). Bandopadhyay *et al.* (2002) found significant increase in number of pods plant^{-1} of mungbean due to the application of increasing level of K and S.

4.3.4 Interaction effect of potassium and sulphur on pod length

The interaction effects of K and S produced significant variation on pod length (Table 4.5). The highest pod length (10.61 cm) was recorded in the treatment combination of K_2S_2 (25 kg K ha^{-1}+ 6 kg S ha^{-1}) and the lowest pod length (6.05 cm) was found in K_0S_0.

4.3.5 Interaction effect of potassium and sulphur on number of seeds pod^{-1}

The interaction effects of different doses of K and S on number of seeds pod^{-1} of mungbean was statistically significant (Table 4.6). The highest number of seeds pod^{-1} (13.12) was recorded with the treatment combination of K_2S_2 (25 kg K ha^{-1} + 6 kg S ha^{-1}) and the lowest number of seeds pod^{-1} (8.050) was found in K_0S_0 (0 kg K ha^{-1}+ 0 kg S ha^{-1}) treatment.

4.3.6 Interaction effect of potassium and sulphur on weight of 1000-seed

The interaction effects of different doses of K and S on the weight of 1000-seed of mungbean was statistically significant (Table 4.6). The highest weight of 1000-seed (45.78 g) was recorded with the treatment combination of K_2S_2 (25 kg K ha^{-1} + 6 kg S ha^{-1}) and the lowest weight of 1000-seed (38.63 g) was found in K_0S_0 (0 kg K ha^{-1}+ 0 kg S ha^{-1}).

Table 4.6 Interaction effect of potassium and sulphur on yield and yield contributing characters

Treatments	No. of seeds pod^{-1}	1000-seed wt (gm)	Grain yield ($t\ ha^{-1}$)	Stover yield ($t\ ha^{-1}$)
K_0S_0	8.05 g	38.63 f	1.063 i	1.997 h
K_0S_1	9.29 f	39.52 e	1.120 h	2.070 gh
K_0S_2	10.19 de	41.51 c	1.157 gh	2.133 fg
K_1S_0	9.94 e	40.67 d	1.203 g	2.143 fg
K_1S_1	10.66 cd	41.88 c	1.260 f	2.173 f
K_1S_2	10.89 c	43.45 b	1.357 e	2.373 d
$K_2 S_0$	10.56 cd	42.00 c	1.380 de	2.273 e
K_2S_1	12.12 b	43.83 b	1.427 cd	2.420 cd
K_2S_2	13.12 a	45.78 a	1.783 a	2.660 a
K_3S_0	10.67 cd	42.01 c	1.417 cd	2.420 cd
K_3S_1	11.00 c	44.02 b	1.493 b	2.463 c
K_3S_2	10.84 c	43.87 b	1.447 bc	2.543 b
$LSD_{(0.05)}$	0.571	0.833	0.053	0.075
CV (%)	3.18	1.16	2.49	1.97

In a column figures having similar letter(s) do not differ significantly whereas figures with dissimilar letter(s) differ significantly.

4.3.7 Interaction effect of potassium and sulphur on grain yield

The interaction effects of different doses of K and S on the grain yield of mungbean was significant (Table 4.6). The highest grain yield of mungbean (1.783 $t\ ha^{-1}$) was recorded with the treatment combination of K_2S_2 (25 kg K ha^{-1} + 6 kg S ha^{-1}) and the lowest grain yield of mungbean (1.063 $t\ ha^{-1}$) was found in K_0S_0 treatment (0 kg K ha^{-1}+ 0 kg S ha^{-1}).

4.3.8 Interaction effect of potassium and sulphur on stover yield

The interaction effects of different doses of K and S on the stover yield was significant (Table 4.6). The highest stover yield (2.660 t ha^{-1}) was recorded with the treatment combination of K_2S_2 (25 kg K ha^{-1}+ 6 kg S ha^{-1}) and the lowest stover yield (1.997 t ha^{-1}) was found in treatment K_0S_0 (0 kg K ha^{-1}+ 0 kg S ha^{-1}).

4.4 Effect of Potassium on nutrient content in mungbean stover

4.4.1 Effect of K on nitrogen content in mungbean stover

Application of K showed significant variation in the nitrogen concentration in mungbean stover (Table 4.7).The N concentration in mungbean stover increased with increasing level of K up to 25 Kg K ha^{-1}. The highest nitrogen concentration in stover (0.7400 %) was recorded in K_1 (15 kg K ha^{-1}). On the other hand, the lowest nitrogen concentration in stover (0.6300 %) was recorded in the K_0 treatment where no K was applied.

4.4.2 Effect of K on phosphorus content in mungbean stover

Application of K showed significant variation in the phosphorus concentration in mungbean stover (Table 4.7). The highest phosphorus concentration in stover (0.5822 %) was recorded in K_2 (25 kg K ha^{-1}). On the other hand, the lowest phosphorus concentration in stover (0.4056 %) was recorded in the K_0 treatment where no K was applied.

Table 4.7 Effect of potassium on total N P K and S concentrations in mungbean stover

Treatments	N (%)	P (%)	K (%)	S (%)
K_0	0.6300 c	0.4056 c	0.8122c	0.105
K_1	0.7400 a	0.5533 a	1.124 b	0.310
K_2	0.7156 ab	0.5822 a	1.409 a	0.123
K_3	0.6828 bc	0.4633 b	1.141 b	0.112
$LSD_{(0.05)}$	0.053	0.053	0.053	NS
CV (%)	3.89	5.05	2.02	

In a column figures having similar letter(s) do not differ significantly whereas figures with dissimilar letter(s) differ significantly.

4.4.3 Effect of K on potassium content in stover

A statistically significant variation was observed in potassium concentration in stover of mungbean with different doses of potassium (Table 4.7). The highest potassium concentration among the different doses of potassium (1.409 %) was recorded in K_2 (25 kg K ha^{-1}). on the other hand, the lowest potassium concentration (0.8122 %) was recorded in the K_0 treatment where no K was applied.

4.4.4 Effect of K on sulphur content in mungbean stover

A statistically non significant variation was observed in sulphur concentration in stover of mungbean with different doses of K (Table 4.7). Among the different doses of K the highest sulphur concentration in plant (0.310 %) was recorded in K_1 (15 kg K ha^{-1}) treatment. On the other hand, the lowest sulphur concentration (0.105 %) was recorded in the K_0 treatment where no K was applied.

4.5 Effect of Sulphur on nutrient content in mungbean stover

4.5.1 Effect of S on nitrogen content in mungbean stover

The effect of different doses of sulphur showed statistically significant difference in nitrogen concentration in mungbean stover (Table 4.8). The N content in mungbean increased with increasing rate of S. The highest nitrogen concentration among the treatments of sulphur (0.7571 %) was observed in S_2 (6 kg S ha^{-1}). The lowest nitrogen concentration (0.6150 %) was observed in S_0 (control) treatment.

4.5.2 Effect of S on phosphorus content in mungbean stover

The P content in mungbean stover was influenced significantly by the different doses of sulphur (Table 4.8). The highest phosphorus concentration of 0.539 % was observed in S_2 (6 kg S ha^{-1}) treatment. The lowest phosphorus concentration of 0.440 % was observed in S_0 (control condition) treatment.

Table 4.8 Effect of sulphur on total N P K and S concentrations in mungbean stover

Treatments	N (%)	P (%)	K (%)	S (%)
S_0	0.615 b	0.440 b	1.047 c	0.094 b
S_1	0.704 a	0.524 a	1.132 b	0.119 ab
S_2	0.757 a	0.539 a	1.186 a	0.150 a
$LSD_{(0.05)}$	0.053	0.053	0.053	0.053
CV (%)	3.89	5.05	2.02	3.49

In a column figures having similar letter(s) do not differ significantly whereas figures with dissimilar letter(s) differ significantly.

4.5.3 Effect of S on potassium content in mungbean stover

Interaction effects among the different doses of S showed a statistically significant variation in the potassium concentration in mungbean stover (Table 4.8). The accumulation of K increased in higher level of S application. The highest and statistically superior potassium concentration among the different doses of S (1.186 %) was recorded with S_2 treatment. The lowest potassium concentration (1.047 %) was observed in the treatment S_0 where no S was applied.

4.5.4 Effect of sulphur on sulphur content in mungbean stover

The effect of different doses of S showed a statistically significant variation in the sulphur concentration of stover of mungbean (Table 4.8). The highest sulphur concentration in plant among different doses of S (0.150 %) was recorded with S_2 treatment which was statistically identical to the S_1 treatment. The lowest sulphur concentration (0.094 %) was observed in the treatment S_0 where no S fertilizer was applied.

4.6 Effect of Potassium and Sulphur on nutrient content in mungbean stover

4.6.1 Interaction effect of potassium and sulphur on nitrogen concentrations in mungbean stover

Significant effect of combined application of different doses of K and S on the nitrogen concentration was observed in the stover of mungbean (Table 4.9). The highest concentration of nitrogen in the stover (0.820 %) was recorded with the highest dose of K_1S_2 (15kg K ha^{-1} + 6kg S) $ha^{-1}$and the lowest nitrogen concentration (0.530 %) in stover was found in K_0S_0 (0 kg K ha^{-1}+ 0 kg S ha^{-1}) treatment.

4.6.2 Interaction effect of potassium and sulphur on phosphorus concentrations in mungbean stover

There was a marked influence of the different doses of K and S on the phosphorus concentration was observed in the stover of mungbean (Table 4.9)

Table 4.9 Interaction effect of potassium and sulphur on N P K and S concentrations in mungbean stover

Treatments	N (%)	P (%)	K (%)	S (%)
K_0S_0	0.5300 f	0.3433 f	0.6567 j	0.08403 c
K_0S_1	0.6067 e	0.4267 e	0.8667 i	0.1183 a-c
K_0S_2	0.7533 bc	0.4467 de	0.9133 i	0.1410 a-c
K_1S_0	0.6400 e	0.4767 c-e	1.050 h	0.09467 bc
K_1S_1	0.7600 bc	0.5700 b	1.069 gh	0.1207 a-c
K_1S_2	0.8200 a	0.6133 b	1.252 d	0.1497 ab
$K_2 S_0$	0.6267 e	0.4867 cd	1.347 c	0.09567 bc
K_2S_1	0.7133 cd	0.5867 b	1.412 b	0.1197 a-c
K_2S_2	0.8067 ab	0.6733 a	1.470 a	0.1723 a
K_3S_0	0.6633 de	0.4533 de	1.133 ef	0.1047 bc
K_3S_1	0.7367 c	0.5133 c	1.180 e	0.1177 a-c
K_3S_2	0.6483 e	0.4233 e	1.109 fg	0.1377 a-c
$LSD_{(0.05)}$	0.05355	0.05355	0.05355	05355
CV (%)	3.89	5.05	2.02	3.49

In a column figures having similar letter(s) do not differ significantly whereas figures with dissimilar letter(s) differ significantly.

4.6.3 Interaction effect of K and S on total potassium content in mungbean stover

Significant effect of combined application of different doses of K and S on the potassium concentration was observed in stover of mungbean (Table 4.9). The highest concentration of potassium in the stover (1.470 %) was recorded for the treatment K_2S_2 (25 kg K ha^{-1}+ 6 kg S ha^{-1}) treatment and it was statistically superior to that of another treatments. The lowest potassium concentration (0.6567 %) was found for the treatment K_0S_0 (0 kg K ha^{-1}+ 0 kg S ha^{-1}).

4.6.4 Interaction effect of K and S on sulphur content in mungbean stover

Insignificant effect of combined application of different doses of K and S on the sulphur concentration was observed in stover of mungbean (Table 4.9). The highest concentration of sulphur in the stover (0.1723 %) was recorded with the K_2S_2 treatment (25 kg K ha^{-1}+ 6 kg S ha^{-1}). On the other hand, the lowest sulphur concentration (0.08403 %) was found in K_0 S_0 (0 kg K ha^{-1}+ 0 kg S ha^{-1}) treatment.

4.7 Effect of Potassium on nutrient content in mungbean seed

4.7.1 Effect of K on nitrogen content in mungbean seed

Application of K showed significant variation in the nitrogen concentration in mungbean seed (Table 4.10). The highest nitrogen concentration in seed (7.029 %) was recorded in K_2 (25 kg K ha^{-1}). On the other hand, the lowest nitrogen concentration in seed (6.416 %) was recorded in the K_0 treatment where no K was applied. Chanda *et al.* (2002) found significant increase of nitrogenconcentration in mungbean seed due to the application of K fertilizer.

Table 4.10 Effect of potassium on total N P K and S concentrations in mungbean seeds

Treatments	N (%)	P (%)	K (%)	S (%)
K_0	6.504 bc	0.476 b	1.219 c	0.337 c
K_1	6.521 b	0.517 b	1.623 b	0.470 ab
K_2	7.029 a	0.593 a	1.901 a	0.522 a
K_3	6.416 c	0.506 b	1.870 a	0.432 b
$LSD_{(0.05)}$	0.092	0.053	0.053	0.053
CV (%)	0.86	4.47	2.03	6.75

In a column figures having similar letter(s) do not differ significantly whereas figures with dissimilar letter(s) differ significantly.

4.7.2 Effect of K on phosphorus content in mungbean seed

Application of K increased phosphorus concentration in mungbean plant (Table 4.10). The highest phosphorus concentration in seed (0.593 %) was recorded in K_2 (25 kg K ha^{-1}). On the other hand, the lowest phosphorus concentration in seed (0.476 %) was recorded in the K_0 treatment where no K was applied. Increased P concentration in mungbean seed was also reported by Kaushik *et al.* (1996) found significant increase of phosphorus concentration in mungbean seed due to the application of K_2SO_4.

4.7.3 Effect of K on potassium content in seed

A statistically significant variations was observed in potassium concentration in seed of mungbean with different doses of K (Table 4.10). The highest potassium concentration among the different doses of K (1.901 %) was recorded in K_2 (25 kg K ha^{-1}) in seed. The treatment K_2 was statistically similar to K_3. The lowest potassium concentration in mungbean seed (1.219 %) was recorded in the K_0 treatment where no K was applied.

4.7.4 Effect of K on sulphur content in mungbean seed

Sulphur concentrations in mungbean seed varied significantly with different doses of K (Table 4.10). Among the K doses the highest sulphur concentration in seed (0.522 %) was recorded in K_2 (25 kg K ha^{-1}) treatment that did not differ statistically with the treatment K_1. The lowest sulphur concentration in seed (0.337 %) was obtained from having no potassium recorded in the K_0 treatment where no K was applied.

4. 8 Effect of Sulphur on nutrient content in mungbean seed

4.8.1 Effect of S on nitrogen content in mungbean seed

The effect of different doses of sulphur showed statistically significant difference in nitrogen concentration in mungbean seed (Table 4.11). The highest nitrogen concentration among the treatments of sulphur (6.902 %) was observed in S_2 (6kg S ha^{-1}). The lowest nitrogen concentration (6.329 %) was observed in S_0 (control condition) treatment.

Table 4.11 Effect of sulphur on total N P K and S concentrations in mungbean seeds

Treatments	Total N (%)	P (%)	K (%)	S (%)
S_0	6.329 c	0.481 b	1.530 b	0.346 c
S_1	6.622 b	0.541 a	1.713 a	0.456 b
S_2	6.902 a	0.547 a	1.717 a	0.518 a
$LSD_{(0.05)}$	0.092	0.053	0.053	0.053
CV (%)	0.86	4.47	2.03	6.75

In a column figures having similar letter(s) do not differ significantly whereas figures with dissimilar letter(s) differ significantly.

4.8.2 Effect of S on phosphorus content in mungbean seed

Concentration of P in mungbean seed was affected significantly due to the application of different doses of S (Table 4.11). The highest phosphorus concentration among the treatments of S (0.547%) was observed in S_2 (1.5 kg S ha^{-1}). The lowest phosphorus concentration (0.481 %) was found in plants raised without S fertilization. S_0 (0 kg S ha^{-1}) treatment. The treatments S1 and S2 were statistically similar in terms of P concentration in mungbean seed.

4.8.3 Effect of S on potassium content in mungbean seed

The effect of different doses of S showed a statistically significant variation in the potassium concentration in mungbean seed (Table 4.11). The highest and statistically superior potassium concentration in mungbean seed (1.717 %) was recorded in 6 Kg S ha^{-1}. The lowest potassium concentration (1.530 %) in seed was observed in the treatment having no S was applied.

4.8.4 Effect of S on sulphur content in mungbean seed

The effect of different doses of S showed significant variation in sulphur concentration in the seed of mungbean (Table 4.11). The highest sulphur concentration (0.5183 %) in seed among different doses of S fertilizer was recorded with S_2 treatment (6 kg Zn ha^{-1}). The lowest sulphur concentration (0.3467%) in seed was observed in the treatment S_0 where no sulphur fertilizer was applied.

4.9.1 Interaction effect of K and S on nitrogen concentrations in mungbean seed

Significant effect of combined application of different doses of K and S on the nitrogen concentration was observed in the seed of mungbean (Table 4.12). The highest concentration of nitrogen in the seed (7.473 %) was recorded with the treatment combination K_2S_2 (25 kg K ha^{-1}+ 6 kg S ha^{-1}). The lowest nitrogen concentration (5.747 %) in seed was found in K_0S_0 (No

K+ No S) treatment combination. Singh *et al.* (1993) found significant increase of nitrogen concentration in mungbean due to the application of increasing level of K fertilizer.

Table 4.12 Interaction effects of potassium and sulphur on N P K and S concentrations in mungbean seeds

Treatments	Total N (%)	P (%)	K (%)	S (%)
K_0S_0	5.747 h	0.423 f	1.167 h	0.246 f
K_0S_1	6.793 cd	0.473 d-f	1.243 g	0.340 e
K_0S_2	6.973 b	0.533 b-d	1.247 g	0.426 cd
K_1S_0	6.223 f	0.490 c-e	1.467 f	0.390 de
K_1S_1	6.287 f	0.526 b-d	1.627 e	0.463 c
K_1S_2	7.053 b	0.536 bc	1.777 d	0.556 b
K_2 S_0	6.757 d	0.516 cd	1.577 e	0.356 e
K_2S_1	6.857 c	0.5833 b	1.910 c	0.560 b
K_2S_2	7.473 a	0.6800 a	2.217 a	0.650 a
K_3S_0	6.590 e	0.4967 c-e	1.910 c	0.393 de
K_3S_1	6.550 e	0.5833 b	2.073 b	0.463 c
K_3S_2	6.107 g	0.4400 ef	1.627 e	0.440 cd
$LSD_{(0.05)}$	0.092	0.053	0.053	0.053
CV (%)	0.86	4.47	2.03	6.75

In a column figures having similar letter(s) do not differ significantly whereas figures with dissimilar letter(s) differ significantly.

4.9.2 Interaction effect of K and S on phosphorus concentrations in mungbean seed

Significant effect of combined application of different doses of K and S on the phosphorus concentration was observed in mungbean seed (Table 4.12).The highest concentration of phosphorus in the seed (0.68 %) was recorded with the treatment combinations K_2S_2. The lowest phosphorus concentration (0.423 %) in seed was recorded without K and S application (K_0S_0).

4.9.3 Interaction effect of K and S on potassium content in mungbean seed

Significant effect of combined application of different doses of K and S on the potassium concentration was observed in seed of mungbean (Table 4.12). The highest concentration of potassium in the seed (2.217 %) was recorded with the treatment combination of K_2S_2. The lowest potassium concentration (1.167 %) in seed was found in K_0S_0 treatment combination.

4.9.4 Interaction effect of K and S on sulphur content in mungbean seed

Combined application of K and S affected sulphur concentration in mungbean seed (Table 4.12). The highest concentration of sulphur in seed (0.65 %) was recorded with the higher dose of K and S which may be due to the higher supply and subsequent assimilation of these elements in the seed. The lowest sulphur concentration (0.246 %) in seed was found in K_0S_0 treatment combination.

4.10 Effect of Potassium on nutrient content in the post harvest soil of mungbean field

44.10.1 Effect of potassium on total nitrogen content in the post harvest soil of mungbean field

Statistically insignificant variation was observed in nitrogen concentration in post harvest soil of mungbean field with different doses of K (Table 4.13). Considering the different doses of K the highest nitrogen concentration in soil (0.0944 %) was recorded in K_2 (25 kg K ha^{-1}). The lowest nitrogen concentration in soil (0.0793%) was recorded in the K_0 treatment with no K was applied.

Table 4.13 Effect of Potassium on total N, available P, available K and available S contents of the post harvest soil of mungbean field

Treatments	Total N (%)	Available Phosphorus (ppm)	Available K (ppm)	Available S (ppm)
K_0	0.0793	16.94 c	46.47d	19.38d
K_1	0.0843	17.93 b	52.74c	20.39 c
K_2	0.0944	19.89 a	67.76 a	23.17 b
K_3	0.0795	19.27 a	56.29b	23.52 a
$LSD_{(0.05)}$	NS	0.675	1.692	0.053
CV (%)	3.05	2.15	1.79	1.15

In a column figures having similar letter(s) do not differ significantly whereas figures with dissimilar letter(s) differ significantly.
NS : Non significant

4.10.2 Effect of potassium on available phosphorus content in the post harvest soil of mungbean field

Significant variation was observed in phosphorus concentration in postharvest soil with different doses of K (Table 4.13). The highest phosphorus concentration in soil (19.89 ppm) was recorded in K_2 (25 kg K ha^{-1}). The lowest phosphorus concentration in soil (16.94 ppm) was found in K_0 treatment .

4.10.3 Effect of potassium on available potassium content in the post harvest soil of mungbean field

Potassium concentration in postharvest soil of mungbean with different doses of K was found significant (Table 4.13). The highest potassium concentration in soil (67.76 ppm) was recorded in K_2 (25 kg K ha^{-1} and the lowest potassium concentration in soil (46.47 ppm) potassium concentration was recorded in K_0 treatment. Prasad *et al.* (2000) found significant increase of potassium concentration in the post harvest soil of summer mungbean field due to the application of 20- 30 kg K ha^{-1}.

4.10.4 Effect of potassium on available sulphur content in the post harvest soil of mungbean field

Statistically significant variation was observed in sulphur concentration in the post harvest soil of mungbean with different doses of K (Table 4.13). Considering the different doses of K the highest sulphur concentration in soil (23.52 ppm) was recorded in K_2 (25 kg K ha^{-1}) treatment. The lowest sulphur concentration in soil (19.38 ppm) was recorded in the K_0 treatment where no K was applied.

4.11 Effect of Sulphur on nutrient content in in the post harvest soil of mungbean field

4.11.1 Effect of S on total nitrogen content in the post harvest soil of mungbean field

The effect of different doses of S did not show significant variation in the nitrogen concentration in post harvest soil (Table 4.14).

4.11.2 Effect of S on available phosphorus content in the post harvest soil of mungbean field

Significant variation in phosphorus concentration in the soil of mungbean field (Table 4.14) was observed due to S application. Among the different treatments S_2 (6 kg S ha^{-1}) showed the highest phosphorus concentration (20.70 ppm). But S_1 and S_2 has no significant difference. The lowest phosphorus concentration (14.72 ppm) in soil was observed in the treatment S_0 where no S fertilizer was applied.

Table 4.14 Effect of S on total N, available P available K and available S contents of the post harvest soil of mungbean field

Treatments	Total N (%)	Available Phosphorus (ppm)	Available K (ppm)	Available S (ppm)
S_0	0.07975	14.72 b	54.53 b	20.11 c
S_1	0.08725	20.10 a	56.48 a	21.15 b
S_2	0.08625	20.70 a	56.43 a	23.60 a
$LSD_{(0.05)}$	NS	0.6752	1.692	0.05355
CV (%)	3.05	2.15	1.79	1.15

In a column figures having similar letter(s) do not differ significantly whereas figures with dissimilar letter(s) differ significantly.
NS : Non significant

4.11.3 Effect of S on available potassium content in the post harvest soil of mungbean field

The effect of different doses of S produced significant differences in the potassium concentration in soil of mungbean field (Table 4.14). Among the different doses of S , S_1 (3 kg S ha^{-1}) gave the highest potassium concentration (56.48 ppm) in soil. Statistically the treatments S_1 and S_2 were identical. The lowest potassium concentration (54.53 ppm) in soil was observed in the S_0 treatment where no S fertilizer was applied.

4.11.4 Effect of S on available sulphur content in the post harvest soil of mungbean field

The effect of different doses of S showed a statistically significant difference in the sulphur concentration in soil of mungbean field (Table 4.14). Among the different treatments of fertilizer doses, S_2 (6 kg S ha^{-1}) showed the highest sulphur concentration (23.60 ppm) in soil. The lowest sulphur concentration (20.11 ppm) in soil was observed in the treatment S_0 where no S fertilizer was applied.

4.12.1 Interaction effect of Potassium and Sulphur on total nitrogen and phosphorus content of the post harvest soil of mungbean field

No significant difference on soil nitrogen was observed in postharvest soil due to combined application of K and S (Table 4.15). But a significant effect on available phosphorus was observed in postharvest soil due to combined application of K and S . The highest phosphorus concentration (22.50 ppm) was recorded in the treatment combination with K_2S_2 (25 kg K ha^{-1}+ 6 kg S ha^{-1}). On the other hand, the lowest phosphorus concentration (12.30 ppm) in soil was found in K_0S_0 treatment combination.

4.12.2 Interaction effect of Potassium and Sulphur on available Potassium and Sulphur content of the post harvest soil of mungbean field

Significant effect of combined application of different doses of K and S on the potassium and sulphur concentration was observed in soil of mungbean field (Table 4.15). The highest and superior potassium concentration (71.57 ppm) and sulphur concentration (27.16 ppm) was recorded in the treatment combination of K_2S_2 (25 kg K ha^{-1}+ 6 kg S ha^{-1}). On the other hand, the lowest potassium concentration (41.17 ppm) and sulphur concentration (17.25 ppm)in the post harvest soil was found in K_0S_0 (control condition) treatment.

Table 4.15 Interaction effects of potassium and sulphur on total N available P, available K and available S contents in the post harvest soil of mungbean field

Treatments	Total N (%)	Available Phosphorus (ppm)	Available K (ppm)	Available S (ppm)
K_0S_0	0.07367	12.30 j	41.17 i	17.25 g
K_0S_1	0.07867	18.58 f	49.03 h	19.16 f
K_0S_2	0.08567	19.93 de	49.20 h	21.74 d
K_1S_0	0.07867	13.80 i	51.53 g	19.16 f
K_1S_1	0.08567	19.45 e	52.80 fg	20.28 e
K_1S_2	0.08867	20.55 cd	53.90 f	21.74 d
K_2S_0	0.08200	15.80 h	64.36 c	20.28 e
K_2S_1	0.09400	21.36 b	67.36 b	22.07 d
K_2S_2	0.1073	22.50 a	71.57 a	27.16 a
K_3S_0	0.08467	16.97 g	61.08 d	23.75 b
K_3S_1	0.09067	21.03 bc	56.74 e	23.07 c
K_3S_2	0.06333	19.81 e	51.04 g	23.75 b
$LSD_{(0.05)}$	NS	0.6752	1.692	0.4216
CV (%)	3.05	2.15	1.79	1.15

In a column figures having similar letter(s) do not differ significantly whereas figures with dissimilar letter(s) differ significantly. NS : Non significant

CHAPTER 5

SUMMARY AND CONCLUSION

CHAPTER V

SUMMARY AND CONCLUSION

The experiment was conducted at the Sher-e-Bangla Agricultural University Farm Dhaka 1207 (Tejgaon series under AEZ No.28) during the kharif season of 2012 to study the effect of potassium and sulphur on the growth and yield of mungbean (BARI Mung-6). The soil was loam in texture having pH 6.14 and organic matter content was 1.17%. Four levels of potassium (0, 15, 25 and 35 kg K ha^{-1}) and three levels of sulphur (0, 3 and 6 kg S ha^{-1}) were used in the study. Levels of these two nutrient elements make 12 treatment combinations. The experiment was carried out in randomized complete block design (RCBD)with three replications.

Recommended blanket doses of N and P (45 kg urea and 80 kg TSP respectively) were applied. The whole amounts of TSP, MP and half amounts of Urea fertilizer were applied as basal dose during final land preparation. The rest of half urea was applied 25 days after sowing (DAS). The required amounts of K (from Muriate of Potash) and S (from Gypsum) were applied at a time as per treatment combination after field layout of the experiment and were mixed properly through hand spading.

Mungbean seeds were sown on 18th April 2012 and the crop was harvested on 20th June 2012. The data were collected plot wise for plant height (cm), number of branches $plant^{-1}$, number of pods $plant^{-1}$, pod length, number of seeds pod^{-1} (cm), weight of 1000-seed (g), grain yield (t ha^{-1}) and stover yield (t ha^{-1}) .

The plot wise post harvest soil samples from 0-15 cm depth were collected and analyzed for N, P, K and S contents. Seed and stover samples were also chemically analyzed for total N, P, K and S contents. All the data were statistically analyzed following F-test and the mean comparison was made by LSD. The results of the experiment are stated below.

Plant height was significantly affected by different levels of K and S. Plant height increased with increasing levels of K and S individually. The individual application of K @ 25 kg ha^{-1} (K_2) produced the tallest plant (52.00cm). Whereas application of S @ 6 kg ha^{-1} produced the smallest plant (48.84 cm). The tallest plant (54.38 cm) was found in K_2S_2 treatment combination which was higher than control treatment (39.90 cm). The individual application of K and S showed positive effect on the number of branches per plant, number of pod per plant, number of seeds per pod, weight of 1000 seed, grain yield and stover yield. All the plant characters increased with increasing levels of K and S up to higher level.

Like all other plant characters, gain yield of mungbean was influenced significantly due to application of K and S. Grain yield increased with increasing levels of K and S up to certain level. The highest grain yield (1.597 t ha^{-1}) was found in plants receiving K @25 kg ha^{-1} and the lowest was recorded in K_0 treatment. The individual application of S @ 6 kg ha^{-1} produced the highest amount of grain yield (1.511 t ha^{-1}). The combined application of K and S had positive effect on grain yield of mungbean. The highest grain yield of mungbean was recorded in K_2S_2 treatment which was statistically identical with each other. The lowest yield was recorded in K_0S_0 treatment. Combined application of K @ 25 kg ha^{-1} and S @ 6 kg ha^{-1} produced higher grain yield as compared to control treatment significantly.

Nutrient contents (N, P, K and S) on stover were positively affected due to K and S fertilization. The interaction effect of K and S was also found remarkable. The N, P, K and S content in stover varied from 0.53% N in K_0S_0 treatment to 0.821 % N in K_2S_2 treatment, 0.343% P in K_0S_0 treatment to 0.673% P in K_2S_2 treatment, 0.656 % K in K_0S_0 treatment to 1.47% K in K_2S_2 treatment and 0.084% S in K_0S_0 treatment to 0.172% S in K_2S_2 respectively. Nitrogen (N),P, K and S contents in stover increased with increasing levels of K and S up to certain level.

Nutrient contents (N, P, K and S) in seeds were positively affected due to K and S fertilization. The interaction effect of K and S was also found remarkable. The N, P, K and S content in seeds varied from 5.747% N in K_0S_0 treatment to 7.473% N in K_2S_2 treatment, 0.4233% P in K_0S_0 treatment to 0.68% P in K_2S_2 treatment, 1.167% K in K_0S_0 treatment to 2.217 % K in K_2S_2 treatment, and 0.2467% S in K_0S_0 to 0.65% S in K_2S_2 treatment, respectively. The N, P, K and S contents in seeds also increased with increasing level of K and S up to certain level.

Nutrient content in post harvest soil was also influenced by different levels of K and S application. The available P, available K and available S of post harvest soil varied from 12.30 to 22.50 ppm, 41.17 to 71.57 ppm, 17.25 to 27.16 ppm, respectively due to combined application of K and S at different levels. The addition of K and S not only increased the yield but also protect the soil from total exhaustion of nutrients.

Considering all the parameters studied the following conclusion may be drawn :-

The growth and yield of mungbean responded significantly by the combined application of potassium and sulphur @ 25 kg K ha^{-1} and 6 kg S ha^{-1} respectively.

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

Application of Potassium and sulphur @ 25 kg K ha^{-1} and 6 kg S ha^{-1} (i.e. MOP 50kg and Gypsum 33.34kg) may be the best combination for higher yield of mungbean and also to maintain soil fertility and productivity than their individual application in Tejgaon series under AEZ No.28.

Recommendation may vary from soil to soil. However, to reach a specific conclusion and recommendation more research work on mungbean should be done in different Agro-ecological zones of Bangladesh.

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APPENDICES

Appendix 1. Records of meteorological information (monthly) during the period from March, 2012 to July, 2012

Month	Air temperature (^0C)		Relative humidity (%)	Rainfall (mm)
	Maximum	Minimum		
March, 2012	32	20	45	61
April, 2012	34	23	55	137
May, 2012	33	24	72	245
June, 2012	32	26	79	315
July, 2012	31	26	79	329

Source: http://www.dhaka.climatemps.com/

Appendix-2: Some Commonly Used Abbreviations and Symbols

Abbreviations	Full word
%	Percent
@	At the rate
AEZ	Agro-Ecological Zone
Agric.	Agriculture
Agril.	Agricultural
Agron.	Agronomy
ANOVA	Analysis of variance
BARI	Bangladesh Agricultural Research Institute
BBS	Bangladesh Bureau of Statistics
BD	Bangladesh
BINA	Bangladesh Institute of Nuclear Agriculture
CEC	Cation Exchange Capacity
cm	Centi-meter
CV%	Percentage of coefficient of variation
df	Degrees of Freedom
DMRT	Duncan's Multiple Range Test
EC	Emulsifiable concentration
et al	and others
etc	Etcetera
FAO	Food and Agricultural Organization
g	gram
hr.	Hours
j.	Journal

Kg/ha	kiligrams per hectare
kg	kilogram
m	Meter
m^2	square meter
MOA	Ministry of Agriculture
MSE	Mean square of the error
No.	Number
ppm	parts per million
RCBD	randomized complete block design
Rep.	replication
Res.	research
SAU	Sher-e-Bangla Agricultural University
Sc.	science
SE	Standard Error
Univ.	University
var.	variety

Appendix 3.: Layout of the experimental Field

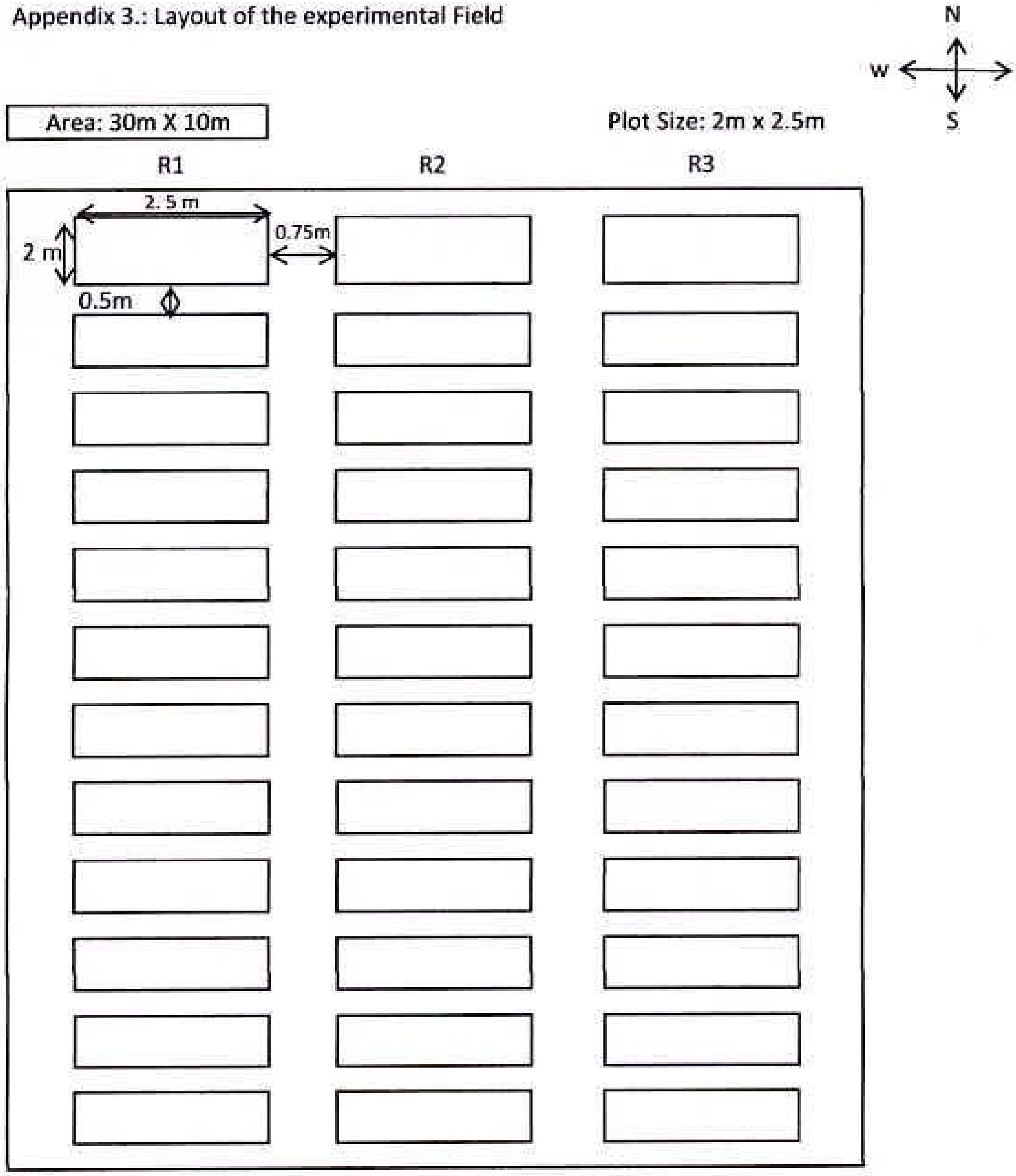

Fig.1: Layout of the experimental field