Effects of Phosphorus and Zinc on the Growth and Yield of Mungbean (BARI mug 6)

M. M. Rahman[1], M. J. Adan[2], M. S. N. Chowdhury[3], M. S. Ali1 and T. S. Mahabub[4]

[1]Department of Agronomy, Sher-e-Bangla Agricultural University, Dhaka-1207, Bangladesh
[2]Department of Pathology, Sher-e-Bangla Agricultural University, Dhaka-1207, Bangladesh
[3]Department of Agricultural Botany , Sher-e-Bangla Agricultural University, Dhaka-1207, Bangladesh
[4]Institute of Seed Technology, Sher-e-Bangla Agricultural University, Dhaka-1207, Bangladesh.

Abstract- A field experiment was conducted at the Sher-e-Bangla Agricultural University Farm, Dhaka 1207, during the kharif season of 2014 to study the effects of Phosphorus and Zinc on the growth and yield of Mungbean **(**BARI Mug 6**)**. Four levels of phosphorus (P) (0, 15, 20 and 25 kg P ha^{-1}) and three levels of zinc (Zn) (0, 1.5 and 3 kg Zn ha^{-1}) were used in the study. The results revealed that seed and stover yield of mungbean increased with increasing levels of phosphorus and zinc up to certain level. Incase of P the maximum significant seed yield (1.5 t ha^{-1}) and stover yield (2.47 t ha^{-1}) were obtained with the treatment P_3 (25 kg P ha^{-1}) and the minimum significant seed yield (1.11 t ha^{-1}) and stover yield (2.06 t ha^{-1}) were obtained with the treatment P_0 (0 kg P ha^{-1}). Incase of Zn the maximum significant seed yield (1.45 t ha^{-1}) and stover yield (2.42 t ha^{-1}) were obtained with the treatment Zn_2 (3 kg Zn ha^{-1}) and the minimum significant seed yield (1.27 t ha^{-1}) and stover yield (2.21 t ha^{-1}) were obtained with the treatment Zn_0 (0 kg Zn ha^{-1}). The maximum significant plant height (52.05 cm), number of branch $plant^{-1}$ (2.87), seed yield (1.68 t ha^{-1}), yield contributing factors like number of pods $plant^{-1}$ (20.86), number of seeds pod^{-1} (12.65) and weight of 1000-seeds (45.11 g) were obtained with the treatment combination P_2Zn_2 (20 kg P ha^{-1} + 3 kg Zn ha^{-1}).

Index Terms- Mungbean, phosphorus, zinc, growth and yield.

I. INTRODUCTION

Mungbean (*Vigna radiata* L.) is one of the important pulse crops of Bangladesh, as it is an excellent source of easily digestible protein [1]. It belongs to the family Leguminosae. BARI mug 6 is a yield potential, innovated by Bangladesh Agricultural Research Institute (BARI) that fits well in crop rotation between two cereal crops [2]. In Bangladesh, daily consumption of pulses is only 14.30 g $capita^{-1}$ day^{-1} [3], while World Health Organization (WHO) suggested 45 g $capita^{-1}$ day^{-1} for a balanced diet. Mungbean is rich source of vegetable protein. It is considered as poor man's meat containing almost triple amount of protein as compared to rice. 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 [4]. Hence, on the nutritional point of view, mungbean is perhaps the best of all other pulses [5]. The excessive uses of N, P, S, K and Zn containing fertilizer decrease nutrient availability as well as yield. So it is essential to recommend the proper combination of nutrients to achieve the maximum and sustainable yield goal. Phosphorus plays a remarkable role in plant physiological processes. Phosphorus is a key constituent of ATP and it plays a significant role in the energy tranformation in plants [6] and also essential for energy storage and release in living cells. The Zn essentially is being employed in functional and structural component of several enzymes, such as carbonic anhydrase, alcohol dehydrase, alkaline phosphatase, phospholipase, carboxypeptidase [7] and RNA polymerase [8]. Further, plants emerging from seeds with lower Zn could be highly sensitive to biotic and abiotic stresses [9]. Zn enriched seeds performs better with respect to seed germination, seedling growth and yield of crops [10]. The farmers of Bangladesh generally grow mungbean with almost no fertilizers. Considering the above facts the present study is aimed at following objectives to determine the effects of phosphorus and Zinc on the growth and yield of mungbean and to study the combine effect of phosphorus and zinc on growth and yield of mungbean.

II. MATERIALS AND METHODS

The experiment was conducted in the experimental farm of Sher-e-Bangla Agricultural University, Sher-e-Bangla Nagar, Dhaka-1207, Bangladesh during the period from April to July, 2014. The location of the experimental site was at 23.75‘ N latitude and $90^0$34‘ E longitude with an elevation of 8.45 meter from sea level. Soil of the study site was silty clay loam in texture belonging to series. The area represents the Agro-Ecological Zone of Madhupur tract (AEZ-28) with P^H 5.8-6.5, ECE-25.28 [11]. BARI mug 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. The plot selected for the experiment was opened by power tiller driven rotovator on the 10th April 2014, afterwards the land was ploughed and cross-ploughed several times followed by laddering to obtain a good tilth. The experiment consisted of two factors: Factor A: Phosphorus (P)**,** P_0= No P ha^{-1}, P_1=15 kg P ha^{-1}, P_2= 20 kg P $ha^{-1}$and P_3= 25 kg P ha^{-1}; Factor B: Zinc (Zn)**,** Zn_0= No Zn ha^{-1}, Zn_1=1.5 kg Zn ha^{-1} and Zn_2=3 kg Zn ha^{-1}. Levels of these two nutrient elements made 12 treatment combinations. The experiment was laid out in a Randomized Complete Block Design (RCBD) with three

replications. The total number of plots was 36, each measuring 2.5 m x 2 m. Recommended blanket doses of N, K and Sulphur (20 kg N from urea, 30 kg K from MoP and 15 kg S ha^{-1} from Gypsum, respectively) were applied. The whole amounts of MoP, Gypsum and half of total Urea fertilizer were applied as basal dose during final land preparation. The rest of the urea fertilizer was applied after 28 days of seed sowing. The required amounts of P (from TSP) and Zn (from Zinc oxide) 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 2014 in lines following the recommended line to line distance of 30 cm and plant to plant distance of 10 cm. 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. The crop was harvested at maturity on 18th June 2014. The harvested crop of each plot was bundled separately. Ten (10) plants from each plot were selected as random and were tagged for the data collection. Data were collected at harvesting stage. The collected data were analyzed with the help of MSTAT-C program and mean values of all the parameters were adjusted by Duncan's Multiple Range Test (DMRT) at 5% level of probability [12].

III. RESULTS AND DISCUSSION

Effect of phosphorus on growth and yield of Mungbean

Mungbean plants showed significant variation in respect of plant height, number of branches $plant^{-1}$, number of pods $plant^{-1}$, number of seeds pod^{-1}, Pod length, weight of 1000-seeds, seed yield (t ha^{-1}) and stover yield (t ha^{-1}) when phosphorus in different doses were applied (Table 1).

Plant height, number of branches $plant^{-1}$, number of pods $plant^{-1}$, number of seeds pod^{-1}: Plant height, number of branches $plant^{-1}$, number of pods $plant^{-1}$, number of seeds pod^{-1}, Pod length and weight of 1000-seeds were increased with P levels from 0-20 kg ha^{-1} then declined. The highest plant height (51.09 cm), number of branches $plant^{-1}$ (2.62), number of pods $plant^{-1}$ (19.36) and number of seeds pod^{-1} (11.73) were obtained with 20 kg P ha^{-1}. On the other hand, the lowest plant height (42.24 cm), number of branches $plant^{-1}$ (1.65), number of pods $plant^{-1}$ (14.70) and number of seeds pod^{-1} (9.40) were observed in the P_0 treatment where no phosphorus was applied. The result is agreed with the findings of Kumar *et al*. [13].

Pod length and weight of 1000-seeds: Pod length and weight of 1000-seeds as affected by different doses of phosphorus showed a statistically significant variation. Among the different doses of P the highest pod length (9.46cm) and weight of 1000-seeds (43.43 g) was observed in P_2 (20 kg P ha^{-1}). The lowest pod length (6.79 cm) and weight of 1000-seeds (40.00 g) were recorded in the P_0 treatment where no phosphorus was applied. The result is agreed with the findings of Kumar *et al*. [13] who observed significant increase in pod length, number of grains pod^{-1}, weight of 1000-seeds, seed yield, and stover yield of mungbean due to the application of increasing level of P fertilizer.

Seed yield and stover yield: Significant variation was observed on the seed yield and stover yield of mungbean when different doses of P were applied (Table 1). The highest seed yield (1.50 t ha^{-1}) was recorded in P_2 (20 kg P ha^{-1}) but the highest stover yield (2.47 t ha^{-1}) was recorded in P_3 (30 kg P ha^{-1}) treatment. The lowest seed yield (1.11 t ha^{-1}) and stover yield (2.06 t ha^{-1}) of mungbean was recorded in the P_0 treatment where no P was applied. There was no significant difference between P_2 and P_3 treatments. The result is agreed with the findings of Oad *et al*. [14] who observed significant increase in grain yield, and straw yield of mungbean due to the application of 100 kg P fertilizer.

Table. 1 Effect of phosphorus on growth parameters

Levels of P (kg ha^{-1})	Plant height (cm)	No. of branches $plant^{-1}$	No. of pods $plant^{-1}$	No. of seeds pod^{-1}	Pod length (cm)	Weight of 1000-seeds (gm)	Seed yield (t ha^{-1})	Stover yield (t ha^{-1})
P_0	42.24 d	1.65 d	14.70 c	9.40 c	6.79 d	40.00 c	1.11 c	2.06 c
P_1	46.50 c	2.21 c	16.90 b	10.48 b	7.59 c	41.89 b	1.29 b	2.23 b
P_2	51.09 a	2.62 a	19.36 a	11.73 a	9.46 a	43.43 a	1.50 a	2.46 a
P_3	49.89 b	2.44 b	17.63 b	10.80 b	8.84 b	42.97 ab	1.50 a	2.47 a
$LSD_{(0.05)}$	1.114	0.0927	0.9975	0.696	0.54	1.18	0.075	0.075

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

Effect of zinc on growth and yield of Mungbean

Mungbean plants showed significant variation in respect of plant height, number of branches $plant^{-1}$, number of pods $plant^{-1}$, number of seeds pod^{-1} , pod length, weight of 1000-seeds, seed yield and stover yield when zinc in different doses were applied (Table 2).

Plant height, number of branches $plant^{-1}$, number of pods $plant^{-1}$ and number of seeds pod^{-1} : Among the different fertilizer doses, Zn_2 (3 kg Zn ha^{-1}) showed the highest plant height (48.26 cm), number of branches $plant^{-1}$ (2.41), number of pods $plant^{-1}$ (18.30) and number of seeds pod^{-1} (11.1). On the contrary, the lowest plant height (46.56 cm), number of branches $plant^{-1}$ (2.04), number of pods $plant^{-1}$ (16.12) and number of

seeds pod^{-1} (9.94) was observed in the treatment where no sulphur was applied. Islam *et al*. [15] found significant increase in plant height, number of branches plant^{-1}, number of pods plant^{-1} and number of seeds pod^{-1} of mungbean due to the application of 0.1% - 0.2% ZnO solution.

Pod length and weight of 1000-seeds: Among the different Zn doses, Zn_2 (3 kg Zn ha^{-1}) showed the highest pod length (8.78 cm) and weight of 1000-seeds (43.23 g). On the other hand, the lowest pod length (7.50 cm) and weight of 1000-seeds (40.91 g) was recorded with Zn_0 treatment where no Zn was applied. Islam *et al*. [15] found significant increase in pod length of mungbean due to the application of 0.l% - 0.2% ZnO solution.

Seed yield and stover yield: Among the different doses of Zn fertilizer, Zn_2 (3 kg Zn ha^{-1}) produced the highest seed yield (1.451 t ha^{-1}) and stover yield (2.423 t ha^{-1}) of mungbean. On the contrary, the lowest seed yield (l.27 t ha^{-1}) and stover yield (2.218 t ha^{-1}) of mungbean were found in Zn_0 where no Zn fertilizer was applied. In case of stover yield Zn_0 and Zn_1 were statistically similar.

Table 2 Effect of zinc on growth parameters

Levels of Zn (kg ha^{-1})	Plant height (cm)	No. of branches plant^{-1}	No. of pods plant^{-1}	No. of seeds pod^{-1}	Pod length (cm)	Weight of 1000-seeds (gm)	**Seed yield** (t ha^{-1})	Stover **yield** (t ha^{-1})
Zn_0	46.56 b	2.04 c	16.12 b	9.94 b	7.50 c	40.91 b	1.27 c	2.21 b
Zn_1	47.46 ab	2.24 b	17.02 b	10.7 a	8.23 b	42.06 ab	1.34 b	2.28 b
Zn_2	48.26 a	2.41 a	18.30 a	11.1 a	8.78 a	43.23 a	1.45 a	2.42 a
$LSD_{(0.05)}$	1.11	0.09	0.99	0.69	0.54	1.18	0.07	0.07

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

Interaction effects of phosphorus and zinc on growth and yield of Mungbean

Combined application of different doses of phosphorus and zinc showed significant effect on the plant height, number of branches plant^{-1}, number of pods plant^{-1}, number of seeds pod^{-1}, pod length, weight of 1000-seeds, seed yield and stover yield of mungbean (Table 3).

Plant height, number of branches plant^{-1}, number of pods plant^{-1} and number of seeds pod^{-1}: The lowest plant height (41.23 cm), number of branches plant^{-1} (1.54), number of pods plant^{-1} (14.05) and number of seeds pod^{-1} (8.71) were observed in the treatment combination of P_0Zn_0 (No phosphorus and No zinc). On the other hand the highest plant height (52.05 cm), number of branches plant^{-1} (2.87), number of pods plant^{-1} (20.86) and number of seeds pod^{-1} (12.65) were recorded with P_2Zn_2 (20 kg P ha^{-1} + 3 kg Zn ha^{-1}) treatment combination (Table 3). Ahmed *et al*. [16] found significant increase in plant height, number of branches plant^{-1}, number of pods plant^{-1} and number of seeds pod^{-1} of mungbean due to the application of increasing level of P and Zn.

Pod length and weight of 1000-seeds: The highest pod length (10.55 cm) and weight of 1000-seeds (45.11g) were recorded in P_2Zn_2 (20 kg P ha^{-1}+ 3 kg Zn ha^{-1}) treatment combination. On the other hand, the lowest pod length (6.42 cm) and weight of 1000-seeds (38.96g) were found in P_0Zn_0 (Table 3). Singh *et al.* [17] found significant increase in pod length and weight of 1000-seeds of mungbean due to the application of increasing level of P fertilizer.

Seed yield and stover yield: The highest seed yield (1.683 t ha^{-1}) and stover yield (2.657 t ha^{-1}) of mungbean were recorded with the treatment combination of P_2Zn_2 (20 kg P ha^{-1} + 3 kg Zn ha^{-1}). On the other hand the lowest seed yield (1.08 t ha^{-1}) and stover yield (2.003 t ha^{-1}) of mungbean were found in P_0Zn_0 (No P and No Zn) and P_0Zn_1 (No P and 1.5 kg Zn) treatment combinations, respectively (Table 3). Singh and Bajpai [18] found that P and Zn significantly improved the grain as well as stover yields of chickpea.

Table 3. Interaction effect of phosphorus and zinc on growth parameters

Interaction of P and Zn	Plant height (cm)	No. of branches plant^{-1}	No. of pods plant^{-1}	No. of seeds pod^{-1}	Pod length (cm)	Weight of 1000-seed (gm)	**Seed yield** (t ha^{-1})	Stover **yield** (t ha^{-1})
P_0Zn_0	41.23 h	1.54 i	14.05 g	8.71 f	6.42 g	38.96 g	1.08 g	2.07 gh
P_0Zn_1	42.14 h	1.59 i	14.64 fg	9.29 ef	6.86 fg	39.52 fg	1.12 g	2.00 h
P_0Zn_2	43.34 g	1.83 h	15.41 f	10.19 cd	7.11 f	41.51 de	1.15 fg	2.13 fg
P_1Zn_0	45.13 f	2.04 g	15.57 f	9.94 de	7.26 f	40.67 ef	1.20 f	2.14 fg
P_1Zn_1	46.26 e	2.24 f	16.62 e	10.66 b-d	7.27 f	41.88 c-e	1.29 e	2.17 f
P_1Zn_2	48.13 d	2.36 de	18.51 bc	10.82 bc	8.26 e	43.12 bc	1.39 d	2.37 de
P_2 Zn_0	49.95 c	2.30 ef	17.84 cd	10.56 b-d	7.92 e	42.00 cd	1.38 d	2.30 e

P_2Zn_1	51.27 ab	2.68 b	19.36 b	11.99 a	9.91 b	43.16 bc	1.46 cd	2.42 cd
P_2Zn_2	52.05 a	2.87 a	20.86 a	12.65 a	10.55 a	45.11 a	1.68 a	2.65 a
P_3Zn_0	49.94 c	2.29 ef	17.01 de	10.57 b-d	8.41 de	42.01 cd	1.41 d	2.42 cd
P_3Zn_1	50.19 bc	2.44 d	17.46 c-e	11.00 b	8.89 cd	43.69 b	1.52 bc	2.46 bc
P_3Zn_2	49.53 c	2.59 c	18.42 bc	10.84 bc	9.24 c	43.20 bc	1.57 b	2.53 b
$LSD_{(0.05)}$	1.11	0.09	0.99	0.69	0.543	1.180	0.075	0.075

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

.

IV. CONCLUSION

Based on the results of the present study, the following recommendation may be drawn - Application of Phosphorus and Zinc fertilizers @ 20 kg P ha^{-1} and 3 kg Zn ha^{-1} 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 in Bangladesh. Recommendation may vary from soil to soil.

REFERENCES

[1] Kaul, A. K. (1982). Pulses in Bangladesh. BARC, Farm Gate. Dhaka. p. 27.

[2] BARI. (1998). Mungbean Cultivation in Bangladesh. A booklet in Bengali. Bangladesh Agril. Res. Ins., Joydebpur, Gazipur.

[3] BBS. (2010). Statistical Year Book of Bangladesh. Statistics Division, Ministry of Planning, Government of the Peoples Republic of Bangladesh. Dhaka. pp. 64-79.

[4] Frauque, A., Haraguchi, T., Hirota, O. and Rahman, M. A. (2000). Growth analysis, yield, and canopy structure in maize, mungbean intercropping. Bu. Inst. of Tropical Agric. Kyushu University Fukuoka, Japan, 23: 61-69.

[5] Khan, M. R. I. (1981). Nutritional quality characters in pulses. In: Proc. MAT. Workshop Pulses. pp. 199 -206.

[6] Sangakara, U. R., Frehner, M. and Nosberger, N. (2001). Influence of soil moisture and potassium fertilizer the vegetative growth of mungbean (Vigna radiata L.). J. Agron. Crop Sci. 186(2): 73-81.

[7] Coleman, J.E. (1991). Zinc proteins: Enzymes, storage proteins, transcription factors and Replication Proteins. Ann. Rev. Biochem. 61: 897-946.

[8] Romheld, V. and Marschner, H. (1991). Function of micronutrients in plants. Micronutrients in Agriculture, ln JJ Mortvedt, FR Cox, LM Shuman, RM Welch, eds, Ed 2. Soil Science Society of America, Madison, Wl, pp. 297-328.

[9] Obata, H., Kawamura, S., Senoo, K. and Tanaka, A. (1999). Changes in the level of protein and activity of Cu/Zn Superoxide dismutase in Zinc deficient rice plants. Oryza savita L. Soil Sci. Plant Nutr. 45: 891-896.

[10] Cakmak, I., Torun, B., Erenoglu, B., Kalayci, M., Yilmaz, A., Ekiz, H., and Brun, H.J. (1996). Zinc deficiency in soils and plants in Turkey and plant mechanism involved in Zinc deficiency, Turk. J Agric. (Special issue), 13-23.

[11] Haider, H. M., Ahmad, F. and Mushtaq, F. (1991). Role of physio-morphic characters imparting resistance in cotton against some insect pests. Pak. Entomol., 21: 61-66.

[12] Gomez. K. A. and Gomez, A. A. (1984). Statistical Procedures for Agricultural Research (2nd Edn.). John Willey and Sons, Singapore, pp. 28-92.

[13] Kumar, R., Singh, Y. V., Singh, S., Latare, A. M., Mishra, P. K. and Supriya. (2012). Effect of phosphorus and sulphur nutrition on yield attributes, yield of mungbean (Vigna radiata L. Wilczek). J. Chem. and Pharma. Res. 4(5): 2571-2573.

[14] Oad, F. C., Shah, A. N., Jamro, G. H. and Ghaloo, S. H. (2003). Phosphorus and potassium requirements of mungbean (Vigna radiata). J. Applied Sci. 3(6): 428-431.

[15] Islam. M. S., Bhuiyan, M. S. U. and Miah, M. G. (1989). Effect of zinc on lentil yield and yield components. Lens-News letter. 16(l): 30-32.

[16] Ahmed, A. U., Rahman, S., Begum and Islam, N.M.S. (1986). Effect of phosphorus and zinc apptication on the growth, yield and P, Zn and protein content of mungbean. J. Indian Soc. Soil Sci. 34(2): 305-308.

[17] Singh, A. P., Chaudhury, R. K., and Sharma, R. P. R. (1993). Effect of inoculation and fertilizer levels on yield, nutrient uptake and economics of summer pulses. J. Potassium Res. 90: 176-178.

[18] Singh, G. and Bajpai, M. R. (1982). Response of Chikpea to P and foliar application of Zinc and sulphuric acid. Indian. Agric. Sci. 52(12): 835-837.

AUTHORS

First Author and Corresponding Author: M. M. Rahman, B. Sc. Ag. (hons), Sher-e-Bangla Agricultural University, Dhaka-1207, Bangladesh, E-mail: Kbdpulok@gmail.com
Second Author: M. J. Adan, B. Sc. Ag. (hons), Sher-e-Bangla Agricultural University, Dhaka-1207, Bangladesh,
Third Author: M. S. N. Chowdhury, B. Sc. Ag. (hons), Sher-e-Bangla Agricultural University, Dhaka-1207, Bangladesh,
Fourth Author: M. S. Ali, B. Sc. Ag. (hons), Sher-e-Bangla Agricultural University, Dhaka-1207, Bangladesh,
Fifth Author: T. S. Mahabub, B. Sc. Ag. (hons), Sher-e-Bangla Agricultural University, Dhaka-1207, Bangladesh