EFFECT OF PHOSPHORUS, MOLYBDENUM AND *Rhizobium* INOCULATION ON YIELD AND YIELD ATTRIBUTES OF MUNGBEAN

M.M. RAHMAN[1], M.M.H. BHUIYAN[2], G.N.C. SUTRADHAR[3], M.M. RAHMAN[4] AND A.K. PAUL[5]

[1]Principal Scientific Officer, Soil Science Division, BARI, Joydebpur, Gazipur, [2&4]Scientific Officer, BARI, Regional Agricultural Research Station, Hathazari, Chittagong. [3&5]Professor, SAU, Dhaka, Bangladesh

Accepted for publication: September14, 2008

ABSTRACT

Rahman M.M., Bhuiyan M.M.H., Sutradhar G.N.C., Rahman M.M. and Paul A.K. 2008. *Effect of Phosphorus, Molybdenum and Rhizobium Inoculation on Yield and Yield Attributes of Mungbean.* **Int. J. Sustain. Crop Prod. 3(6):26-33**

An experiment was conducted during *kharif* season, 2005 at Soil Science Division, Bangladesh Agricultural Research Institute to study the effect of phosphorus (P), molybdenum (Mo) and *Rhizobium* inoculation on the yield and yield contributing characters of mungbean (*Vigna radiata*) on a silty clay loam soil. The experiment was laid out in RCBD with four replications. Ten treatments were formulated with the combination of 4 levels of P (0, 20, 40, 60 kg/ha) and 2 levels of Mo (1.0, 1.5 kg/ha) having a common *Rhizobium* inoculant. P and Mo application at the rate of 40 and 1.0 kg/ha respectively, significantly increased yield and yield contributing characters of mungbean compared to uninoculated and control. Highest stover (26.67 g/plant) and grain yield (14.61 g/plant) were obtained with P (40 kg/ha), Mo (1.0 kg/ha) and *Rhizobium* inoculation. Above these levels of P and Mo decreased yield and yield contributing characters. Dry weight of plant tops, seed yield/plant and yield-contributing characters were positively correlated with the number of nodules/plant. Combined application of *Rhizobium* inoculant along with 40 kg P and 1.0 kg Mo/ha was considered to be the suitable combination of fertilizer for mungbean cultivation in silty clay loam soils.

Key words: Phosphorus, Molybdenum, *Rhizobium*, yield and mungbean

INTRODUCTION

Mungbean (*Vigna radiata* L. Wilczek) is one of the important pulses grown in Bangladesh. Being rich in protein it can provide a balanced human diet when taken in combination with cereal which contains low level of protein. The mungbean yield is very low in Bangladesh as compared to other countries of the world (BBS, 1991). It is grown twice a year and due to its short duration can be fitted in our existing cropping system without any major change in the present agricultural practices. Nitrogenous fertilizer is important because it is the main component of amino acid as well as protein. The use of biological nitrogen fixation (BNF) technology in the form of *Rhizobium* inoculants in grain legumes can be an alternative of nitrogenous fertilizer. Mungbean, like other legumes improves soil fertility by fixing atmospheric nitrogen through the process of symbiosis with roots of legume crops and makes nitrogen (N) available to plant. Without proper fertilization by phosphorus, rhizobial activities and nitrogen fixation is depressed because it promotes early root formation and the formation of lateral, fibrous and healthy roots. It is very important for nodule formation and to fix atmospheric nitrogen. Leguminous crops meet up their N requirement through BNF depending on proper growth, development and also leghemoglobin content of the root nodules (Chowdhury *et al.*, 1998). It is supposed that phosphorus is effectively translocated into grain at high rates, since P is necessary for the production of protein, phospholipids and phytin in mungbean grain (Trung and Yoshida, 1982). Mo is directly involved in nitrogen fixing enzymes nitrogenase and N reduction enzyme, nitrate reductase especially for legumes forming root nodules. Its application can play a vital role in increasing mungbean yield through its effect on the plant itself and also on the nitrogen fixation process by *Rhizobium*. Sharma *et al.* (1988) observed that molybdenum was responsible for the formation of nodule tissue and increase in nitrogen fixation and without adequate quantities of molybdenum, nitrogen fixation could not occur and microbial activity was depressed. Works on the effect of phosphorus, molybdenum with *Rhizobium* inoculation is scanty in Bangladesh. So, it is necessary to examine the effects of different levels of those nutrients and to assess their best combination in terms of enhanced nitrogen fixation and productivity of mungbean. In view of these points, the present study was undertaken to find out the best combination of phosphorus, molybdenum and *Rhizobium* inoculants on yield and yield contributing characters of mungbean and to determine the relationship between yield contributing characters influenced by *Rhizobium* inoculants.

MATERIALS AND METHODS

Pot experiment was carried out at Soil Science Division, Bangladesh Agricultural Research Institute, Joydebpur, Gazipur during *kharif* season, 2005 using mungbean variety BARI Mung -5. The experiment was laid out in Randomized Complete Block Design (RCBD) with four replications having each of the pot was filled with 12 kg of soil. Physical and chemical properties of initial soil were estimated by using standard analytical procedures presented in Table 1. Ten treatments were as follows; T_1: Control, T_2: *Rhizobium*(*R*), T_3:P_0+$Mo_{1.0}$+*R*, T_4:P_{20}+$Mo_{1.0}$+*R*, T_5:P_{40}+$Mo_{1.0}$+*R,* T_6:P_{60}+$Mo_{1.0}$+*R*, T_7:P_0+ $Mo_{1.5}$+*R*, T_8:P_{20}+$Mo_{1.5}$+*R*, T_9 :P_{40}+$Mo_{1.5}$+*R* and T_{10}:P_{60}+$Mo_{1.5}$+*R* seeds were sown on. Total amount of urea, MP was applied to the upper half of the pot soil seven days before sowing. Four levels of phosphorus (0, 20, 40 and 60 kg P/ha) as TSP and two levels of molybdenum (1.0 and 1.5 kg Mo/ha) as ammonium molybdate were applied to the pots according to the treatment combinations two days before the sowing. Pit based inoculants were prepared with the strains designated as BARI RVr-2005. Seeds were treated with inoculants @ 30 g/kg of seed using gum arabic as sticker and were sown in the evening. All the agronomic practices like weeding, irrigation, mulching, and plant protection measures were performed as the requirement of the crop. The crop was harvested at full maturity. Harvesting was done in two picking within the 20^{th} of May, 2005. From each pot selected plants were harvested and tied with rope separately and tagged and brought to the threshing floor. The grain and stover yields were estimated. Nitrogen, phosphorus and potassium content and uptake in plant materials were determined. Standard procedures were followed for recording and analyzed the data on different yield parameters and means were compared using LSD at 5% level of significance.

Table 1. Physical and chemical properties of initial soil

Soil Sample From pot	Physical properties			OC (%)	pH	C:N Ratio	Chemical properties				
	Sand (%)	Silt (%)	Clay (%)				Total N (%)	Total P (ppm)	K	Ca	Mg
									meq/100 g dry soil		
Analytical value	18.40	45.60	36.00	1.067	5.6	11.00	0.097	11.00	0.13	6.3	1.8
Critical level	Texture : Silty clay loam						-	14.00	0.2	2.0	0.8
Interpretation	-	-	-	-	Acidic	-	Low	Low	Medium	High	High

RESULTS AND DISCUSSION

Nodulation

Seed inoculation with *Rhizobium* significantly increased nodule number as compared to that of the non-inoculated plants of mungbean (Table 2).Chowdhury *et al.*,(1998) reported that phosphorus application at the rate of 60 kg P_2O_5/ha significantly increased nodulation. Individual effect of P application was pronounced in this study. Among the phosphorus levels, P at the rate of 40 and 60 kg/ha along with 1.0 kg Mo/ha produced significant number of nodules 13.50 and 13.00/plant respectively at flowering stage. Plant received *Rhizobium* inoculation alone or with different levels of P and Mo produced higher number of nodules over uninoculated treatment (control). Chowdhury *et al.* (1998) found that 50 kg P_2O_5/ha with other fertilizers increased 245% nodule number over control. Khanam *et al.* (1993) also found the similar results with lentil. The individual effect of Mo on total number of nodule per plant was also significant (Table 2). Result showed that 1.0 kg Mo/ha produced significantly higher number of nodule per plant than the Mo dose 1.5 kg/ha. The higher number of nodule was obtained with 1.0 kg Mo/ha. Above this level the number of nodule significantly decreased. Similar result was observed with P. Figure 1 showed that with increasing P levels, nodule number per plant decreased significantly after a certain level. Zaman *et al.* (1996) observed that application of Mo @ 1.0 kg/ha produced 97% higher nodule number over control.

Pod Length

Significant variation was observed in pod length due to the application of P, Mo and *Rhizobium* inoculation over control (Table 2). The highest pod length (10.93 cm) was obtained with the T_5, where P was applied at the rate of 40 kg/ha along with 1.0 kg Mo/ha and *Rhizobium.* The lowest pod length (8.32 cm) was found with control. Except control, statistically no variation was observed among other treatments. No effect was also observed due to different levels of Mo application. Pod length was increased 32% with the T_5 than control (Table 2).

Number of pods per plant

Rhizobium inoculant along with P and Mo significantly influenced the number of pod/plant. Number of pod/plant ranged from 17.46 to 23.65. T_5 produced significantly higher pods/plant (23.65), which was though higher than other treatments but statistically identical with T_9 (Table 2). The treatment containing *Rhizobium* inoculant alone produced 20% higher number of pod/plant than control. Muhammad *et al.* (2004) and Malik *et at.* (2002 & 2003) reported that the number of pods per plant of mungbean increased with *Rhizobuim* inoculant in association with P application. There was a positive correlation between the number of pods and the number of nodules and mature seeds yield of the crop (Figure 2).

Number of seeds per pod

Rhizobium, P and Mo influenced significantly on the formation of seeds per pod (Table 2). Number of seeds/pod increased P level upto 40 kg/ha along with Mo 1.5 kg/ha. No variation was observed between Mo level 1.0 and 1.5 kg/ha. The highest number of seeds per pod (11.71) was found with T_5 but statistically identical with the T_6, T_9 and T_{10}. The lowest number of seeds per pod (8.68) was obtained with uninoculated plot (control). It was observed that *Rhizobium* inoculant in association with P and Mo led to increase the number of seeds per pod of mungbean. Similar results were also reported by Landge *et al.* (2002). In the present study, number of seeds per pod had a positive correlation with seed yield/plant (Table 5).

100 Seed weight

Result obtained on seed weight is presented in Table 2. Significant effect was observed on 100 seed wt. due to the application of phosphorus, molybdenum and *Rhizobium* inoculation. Significantly higher 100 seed wt. (5.28 g) was obtained with T_5 but statistically similar with T_6, T_9 and T_{10}. Statistically no effect was observed between with or without inoculum treatments. The highest 100 seed weight (5.28 gm) was recorded with the T_5 (P_{40} + $Mo_{1.0}$ + *R*) and the lowest (3.90 g) with the control. Malik *et al*. (2002) reported that seed inoculation with *Rhizobium* significantly increased 100 grain weight (42.27 g) of mungbean. There was a highly positive correlation between 100 seed weight with seed yield/plant (Table 5).

Stover yield per plant

The highest stover yield per plant was recorded (26.67 g) in T_5 (P_{40} + $Mo_{1.0}$ + *R*) at harvest, which was statistically higher than other treatments. T_4, T_6, T_9 and T_{10} were statistically identical (Table 3). The lowest stover yield per plant was recorded (20.75 g) with control. The stover yield increased ranged from 24.19 to 28.53% than control (Table 3). The effect of phosphorus on stover yield of mungbean was also significantly influenced at harvest. The highest stover yield (26.67 g) per plant was obtained with p level 40 kg/ha, which was significantly higher than other treatments. P rate above 40 kg/ha, stover yield decreased significantly. The lowest stover yield was recorded 25.79 g/plant with 0 kg P/ha. Manpreet *et al.* (2004) also observed the similar trend with mungbean. The effect of molybdenum on mungbean stover yield was also significantly influenced. The stover yields (26.18 g/plant) with 1.0 kg Mo/ha, which was significantly higher than the molybdenum rate 1.5 kg/ha. Wu *et al.* (1994) reported that plant dry weight and the dry weight of different organs in soybean were positively correlated with Mo concentration. The lowest stover yield (20.75g) was recorded with control treatment. Considering interaction effect between phosphorus and molybdenum, the highest stover yield was recorded with 40 kg P and 1.0 kg Mo/ha (Figure 3), which was 28.53% increased than control.

Seed yield per plant

Seed yield was significantly influenced due to the application of P, Mo and *Rhizobium* inoculant and are presented in Table 3. The treatment (T_5) inoculated with *Rhizobium* along with 1.0 kg Mo and 40 kg P/ha produced the highest seed yield (14.61 g/plant), which was 162% higher grain yield than the uninoculated control (T_1) and 53% higher than the *Rhizobium* alone (T_2). Muhammad *et al.* (2004) also observed the similar trend. Satish *et al.* (2003) and Malik *et al.* (2003) also observed that P at 40 and 60 kg/ha increased mungbean grain yield than control. Seed yield per plant of mungbean showed positive correlation with number of nodule per plant, number of pod per plant, number of seed per pod and 100 seed weight of mungbean (Figure 4 and Figure 5). Incase of nodule no. per plant and seed yield, the relationship is described by yield response function $y = 4.88 + 0.6139x$, where y indicates seed yield which varied with number of nodule per plant levels x. Seed yield of mungbean was significantly influenced by different levels of phosphorus. The highest seed yield (14.00 g/plant) was found with 40 kg P/ha, which was significantly higher than other treatments (Figure 6). The lowest seed yield was recorded in control (5.56g/plant).Molybdenum application @ 1.0 kg/ha gave the highest seed yield (14.61 g/plant). Above this level of Mo, the yield of mungbean was gradually decreased (Table 3). Ibupoto and Kotechi (1994) also reported the same with soybean. Seed yield was increased 162.77% over control with the T_4, where P and Mo was applied 40 and 1.0 kg/ha, respectively.

Nitrogen content and uptake by shoot

Nitrogen content and uptake by shoot was significantly influenced by *Rhizobium* inoculant, P and Mo fertilization. Nitrogen content in shoot varied from 3.20 to 4.20% at harvesting stage. The highest N content

4.20% was recorded with T_5, which was significantly higher than other treatments (Table 4). No variation in nitrogen content was observed in between the T_6 and T_9. Singh *et al.* (1992) reported that N content in plant tops increase due to inoculation. Effect of *Rhizobium* inoculant alone or in combination with P recorded significantly higher N uptake by shoot compared to control. Addition of Mo along with *Rhizobium* and P further increased N uptake by shoot. T_5 recorded the highest N uptake (1.09 mg/plant). N content decreased with increasing P level (Table 4). T_5 uptake of N was 58% more over control. Maurya *et al.* (1993) reported that N uptake increased with Mo application in blackgram. In this study a positive correlation was also observed in relation to nodule number and N content in seed and N uptake by shoot with the total number and dry weight of nodules of mungbean (Figure 7 and Figure 8).

Phosphorus content and uptake by shoot

Significant effect was observed due to the application of phosphorus, molybdenum and *Rhizobium* inoculation (Table 4). T_5 showed the highest P content in mungbean stover which was statistically higher than other treatments except T_6 and T_9. The lowest P (0.265%) was found in control but statistically identical with inoculant treatment (Table 4). Phosphorus content was highest in T_5 (0.365%), which was 38% higher than control treatment. Chowdhury (1996) reported that P content increased due to inoculation with *Rhizobium*. The influence of phosphorus, molybdenum and *Rhizobium* inoculant, on P uptake by mungbean shoot was found significant at harvest. Both the P content and weight of shoot directly influenced P uptake. Therefore, the values of P uptake increased with the increase of shoot weight and rate of P application. Phosphorus uptake at harvest was higher with the addition of *Rhizobium* inoculant with P and Mo. The highest P uptake (91.88 mg/plant) was found with the T_6, which was statistically significant with other treatments but identical with T_6 and T_{10}. *Rhizobium* inoculant alone led to uptake 34% higher P over control. These findings are in agreement with the Srivastava and varma (1985). They reported the similar trend in P uptake. Phosphorus content in shoot had a positive correlation with the number and dry weight of nodules at all the growth stages (Table 5).

Potassium content and uptake by mungbean shoot

Data obtained in potassium content and uptakes are presented in Table 4. Phosphorus, molybdenum and *Rhizobium* inoculation significantly influenced potassium content and uptake by shoot. Potassium content in shoot varied from 2.51 to 2.88% at harvest (Table 4). In T_5, potassium content was 2.88%, which was 14.74% higher than control. The T_5, T_6, T_9, and T_{10} were statistically similar. Statistically no variations were observed among the T_7, T_8 and T_4. No variation was also observed between inoculation and without inoculation with *Rhizobium* mungbean. Phosphorus and molybdenum with *Rhizobium inoculation* had effect on K uptake by mungbean shoot. Significantly higher uptake was found with T_5 but statistically similar with T_6 and T_9. T_5 uptake 45% more K than the control.

The results showed that *Rhizobium* inoculants BARI RVr-2005 had positive effect on nodulation, yield and yield contributing characters of mungbean. Phosphorus upto 40 kg/ha increased nodulation and enhanced yield and yield contributing characters of mungbean. Molybdenum upto 1.0 kg/ha enhanced nodulation, yield and yield contributing parameters and above this level yield and yield contributing parameters were decreased significantly. The results indicated that *Rhizobium* inoculation with phosphorus and molybdenum @ 40 and 1.0 kg/ha, respectively performed better in case of yield and yield attributes of mungbean. There is enough scope to explore the production of mungbean in silty clay loam soil in Bangladesh through *Rhizobium* inoculation with phosphorus and molybdenum @ 40 and 1.0 kg/ha, respectively.

Table 2. Effect of phosphorus, molybdenum and *Rhizobium* inoculation on nodule number per plant, pod length, pod per plant, seeds per pod and 100 seed weight of mungbean

Treatment	Nodule number/plant	Pod length (cm)	Pods/plant	Number of seeds/pod	100 seed weight (g)
Control (T_1)	6.75 f	8.32 b	17.46 e	8.64 e	3.90 d
Rhizobium(*R*)(T_2)	11.25 d	8.54 ab	21.85 d	10.82 d	4.08 d
$P_0+Mo_{1.0}+R$ (T_3)	11.75 c	10.43 ab	22.00 d	11.07 cd	4.32 cd
$P_{20}+Mo_{1.0}+R$ (T_4)	13.00 b	10.75 ab	22.25 cd	11.29 bc	4.41 bcd
$P_{40}+Mo_{1.0}+R$ (T_5)	13.50 a	10.93 a	23.65 a	11.71 a	5.28 a
$P_{60}+Mo_{1.0}+R$ (T_6)	13.00 b	10.84 ab	22.85 bc	11.47 ab	4.90 ab
$P_0+Mo_{1.5}+R$ (T_7)	11.75 c	10.32 ab	21.86 d	10.82 d	4.13 d
$P_{20}+Mo_{1.5}+R$ (T_8)	13.00 b	10.55 ab	22.20 ed	11.09 cd	4.34 cd
$P_{40}+Mo_{1.5}+R$ (T_9)	11.75 c	10.75 ab	23.19 ab	11.62 ab	4.97 a
$P_{60}+Mo_{1.5}+R$ (T_{10})	11.00 e	10.79 ab	22.65 bcd	11.40 abc	4.81 abc
LSD (0.05)	0.247	2.235	0.714	0.309	0.507
CV%	1.5	15.1	2.2	1.9	7.7

*The figures in a column having common letter(s) do not differ significantly at 5% level of probability

Table 3. Effect of phosphorus, molybdenum and *Rhizobium* inoculation on yield of mungbean

Treatment	Stover yield/plant (g)	Stover yield increase over control (%)	Seed yield/ plant (g)	Seed yield increase over control (%)
Control (T_1)	20.75 e	-	5.56 h	-
Rhizobium(*R*)(T_2)	25.79 d	24.29	9.53 g	71.40
$P_0+Mo_{1.0}+R$ (T_3)	25.77 d	24.19	10.54 f	89.57
$P_{20}+Mo_{1.0}+R$ (T_4)	26.05 bc	25.54	11.43 e	105.58
$P_{40}+Mo_{1.0}+R$ (T_5)	26.67 a	28.53	14.61 a	162.77
$P_{60}+Mo_{1.0}+R$ (T_6)	26.18 b	26.17	12.77 c	129.68
$P_0+Mo_{1.5}+R$ (T_7)	25.79 d	24.29	9.74 g	75.18
$P_{20}+Mo_{1.5}+R$ (T_8)	25.97 c	25.16	10.68 f	92.08
$P_{40}+Mo_{1.5}+R$ (T_9)	26.09 bc	25.74	13.40 b	141.00
$P_{60}+Mo_{1.5}+R$ (T_{10})	26.08 bc	25.69	12.48 d	124.46
LSD (0.05)	0.146	-	0.264	-
CV%	0.4	-	1.6	-

*The figures in a column having common letter(s) do not differ significantly at 5% level of probability.

Table 4. Effect of phosphorus, molybdenum and *Rhizobium* inoculation on nitrogen content and uptake by shoot at harvest of mungbean

Treatment	Nitrogen (N)		Phosphorus (P)		Potassium (K)	
	Content in shoot (%)	Uptake by shoot (mg/plant)	Content in shoot (%)	Uptake by shoot (mg/plant)	Content in shoot (%)	Uptake by shoot (mg/plant)
Control (T_1)	3.20 f	0.69 f	0.265 c	55.00 c	2.51 d	0.520 f
Rhizobium(*R*)(T_2)	3.33 e	0.86 e	0.268 c	73.84 b	2.51 d	0.645 e
$P_0+Mo_{1.0}+R$ (T_3)	3.50 d	0.92 d	0.300 b	73.91 b	2.64 c	0.702 d
$P_{20}+Mo_{1.0}+R$ (T_4)	3.66 c	0.98 c	0.308 b	81.10 b	2.72 b	0.700 d
$P_{40}+Mo_{1.0}+R$ (T_5)	4.20 a	1.09 a	0.365 a	90.69 a	2.88 a	0.754 a
$P_{60}+Mo_{1.0}+R$ (T_6)	3.88 b	1.01 b	0.355 a	91.88 a	2.84 a	0.735 ab
$P_0+Mo_{1.5}+R$ (T_7)	3.47 d	0.91 d	0.305 b	80.99 ab	2.67 b	0.696 d
$P_{20}+Mo_{1.5}+R$ (T_8)	3.75 c	0.97 c	0.308 b	82.25 ab	2.69 b	0.711 cd
$P_{40}+Mo_{1.5}+R$ (T_9)	3.90 b	1.02 b	0.358 a	82.73 ab	2.87 a	0.745 ab
$P_{60}+Mo_{1.5}+R$ (T_{10})	3.75 c	0.98 c	0.315 b	91.64 a	2.82 a	0.730 bc
LSD (0.05)	0.112	0.032	0.021	11.83	0.079	0.021
CV%	2.07	2.29	4.55	10.14	1.91	2.16

*The figures in a column having common letter(s) do not differ significantly at 5% level of probability.

Table 5. Relationship between different crop characters of mungbean

Parameter	Correlation of coefficient (r value)
Number of nodules vs Nitrogen content in shoot	0.44
Number of nodules vs P content in shoot	0.64
Number of nodules vs Nitrogen uptake by shoot	0.69
Number of nodules vs seed yield/plant	0.81
Husk yield vs seed yield/plant	0.85
Number of nodules vs stover yield	0.92
Number of pods /plant vs seed yield/plant	0.94
Number of seeds/pod vs seed yield/plant	0.94
100 seed weight vs seed yield/plant	0.93
n =40	r value $P_{0.05}$ = 0.367 $P_{0.01}$= 0.470

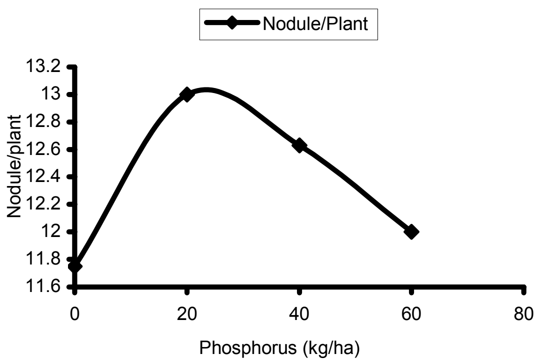

Fig. 1 Effect of phosphorus application on number of nodules per plant of mungbean

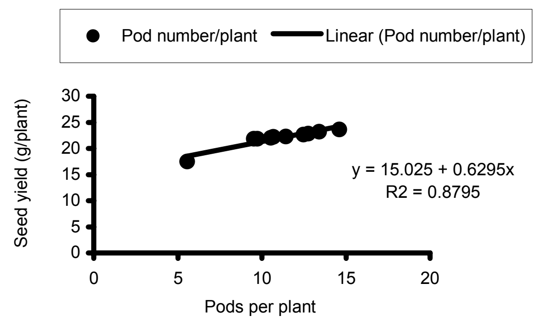

Figure. 2 Relationship between number of pod per plant and seed yield of mungbean

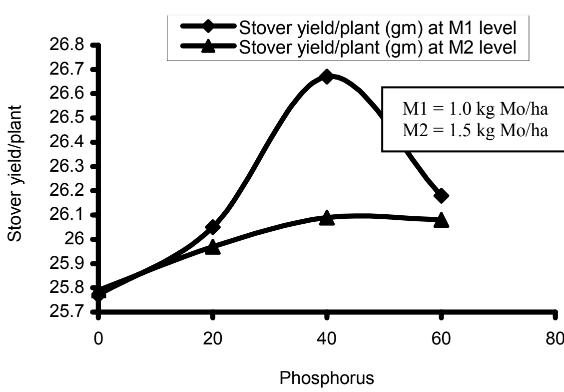

Fig 3. Interaction effect of phosphorus and molybdenum on stover yield of mungbean

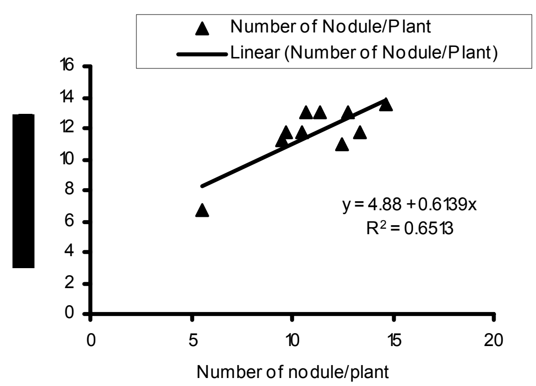

Fig. 4 Relationship between nodule number and seed yield of mungbean

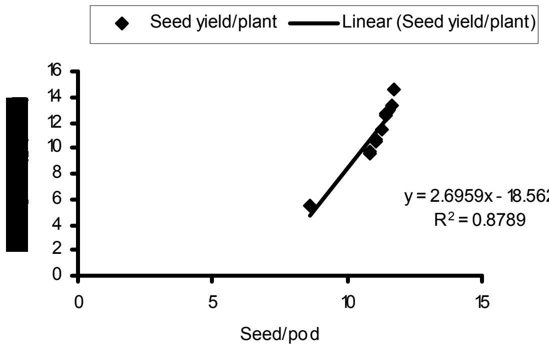

Fig. 5 Relationship between number of seeds per pod and seed yield per plant of mungbean

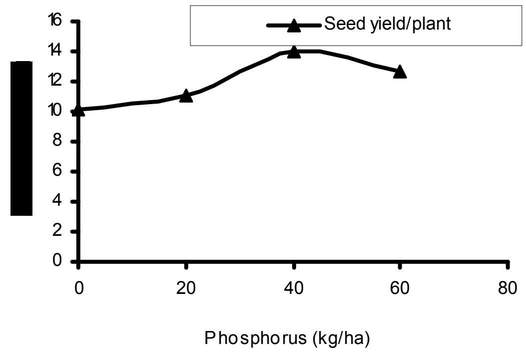

Fig.6 Effect of phosphorus application on seed yield of mungbean

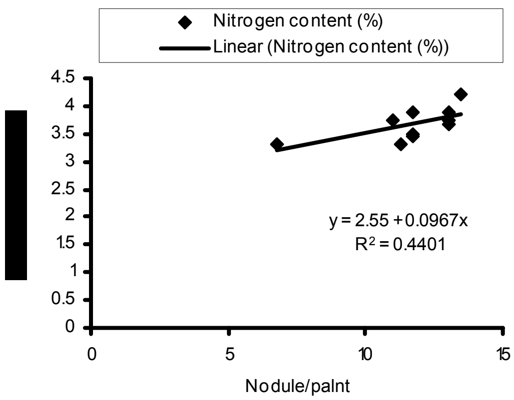

Fig. 7 Relationship between nodule number and nitogen content in shoot of mungbean

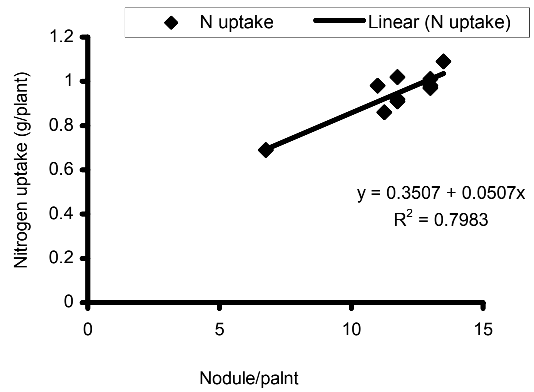

Fig. 8 Relationship between nodule number and nitrogen content in shoot of mungbean

REFERENCES

Bangladesh Bureau of Statistics.(1991). Statistical Year Book of Bangladesh. Govt. of the Peoples Republic of Bangladesh, Dhaka.

Chowdhury, M.U., M.H. Ullah, M.A. Afzal, D. Khanam and S.M. Nabi.(1998). Growth, nodulation and yield of cowpea as affected by *Rhizobium* inoculation and micronutrients in the hilly region. *Bangladesh J. Agril. Res*., 23(2): 195-203.

Chowdhury, M.M. (1996). Response of mungbean [*Vigna radiata* (L.) Wilczek] to *Rhizobium* inoculation and phosphorus application. An unpublished M.S. (Soil Science) Thesis, Institute of Postgraduate Studies in Agriculture (IPSA), Gazipur, Bangladesh.

Ibupoto,A.A. and A. Kotecki. (1994). The effect of soil application of nitrogen fertilizer and foliar application of trace elements on development and yield of soybean. *Pakistan J. Agron*. 20(2): 153-159.

Khanam, D., M.H.H. Rahman, M.A.H. Bhuiyan, A.K.M. Hossain and A.F.M. Rahman. (1993). Effect of rhizobial inoculation and chemical fertilizers on the growth and yield of lentil at two agroecological zones of Bangladesh. *Bangladesh J. Agril. Res*. 18(2): 196-200.

Landge, S.K., S.U. Kakade, P.D. Thakare., A.P. Karunakar and D.J. Jiotode. (2002). Response of soybean to nitrogen and phosphorus. *Pakistan J. Crop Sci*. 3(3): 653-655.

Malik, M.A., S. Hussain, E.A. Warraich, Habib and S.Ullah. (2002). Effect of seed inoculation and phosphorus application on growth, seed yield and quality of mungbean (*Vigna radiata* L.) cv. NM-98. *International Journal of Agriculture and Biology*. 4: 4, 515- 516.

Malik,M.A., M.F. Saleem, Ali Asghar and Mahmood Ijaz. (2003). Effect of nitrogen and phosphorus application on growth, yield and quality of mungbean (*Vigna radiata* L.).*Pakistan Journal of Agricultural Sciences*. 40(3/4): 133-136.

Manpreet, S., H.S. Sekhon and S. Jagrup.(2004). Response of summer mungbean (*Vigna radiata* L. Wilczek) genotypes to different phosphorus levels. *Environment and Ecology*. 22(1): 13-17.

Maurya, B.R., K. Kishor and P.C. Ram. (1993). Effects of iron and molybdenum on soybean. J. Maharastra Agri. Univ. 18(1): 128.

Muhammad, D., A.H. Gurmani and K. Matiullah. (2004). Effect of phosphorus and *Rhizobium* inocualtion on the yield and yield components of mungbean under the rainfed conditions of D.I. Khan. *Sarhad Journal of Agricultural*. 20(4): 575-582.

Satish, K., R.C. Singh and V.S. Kadian. (2003). Response of mungbean genotypes to phosphorus application. *Indian Journal of Pulses Research.* 16(1): 65-66.

Sharma, M.S., M.S. Upadhyay and S.S. Tomar. (1988). Water use efficiency of some rainfed crop on a Vertisol as influenced by soil micronutrients and straw mulching. *Ind. J. Soil Sci*., 33: 387-390.

Singh, B.R., B. Khadelwel and B. Singh. (1992). Effect of manganese and molybdenum fertilization with *Rhizobium* inoculation on the yield and protein content of cowpea. *J. Ind. Soc. Soil Sci*., 40(4): 738-741.

Srivastava, S.N.L. and S.C. Varma. (1985). Effect of nitrogen, phosphorus and molybdenum fertilization on growth, nodulation and residual fertility in field pea. *Ind. J. Agril. Res*. 19(3): 131-137.

Trung, B.C. and S. Yoshida. (1982). Nutrient uptake and its distribution patterns in mungbean. *Japan J. Trop. Agri*. 26(3): 121-129.

Wu, M., C. Xiao, M. C. Wu and C.Z. Ziao. (1994). A study of molybdenum in soybeans. *Soybean Sci*. 13(3): 245-251.

Zaman, A.K.M.M., M.S. Alam. B. Roy and A.H. Beg. (1996). Effect of B and Mo application on mungbean. *Bangladesh J. Agril. Res*. 21(1): 118-124.