J.Soil.Nature. 2 (2):25-30 (July 2008)

EFFECT OF PHOSPHORUS, MOLYBDENUM AND *Rhizobium* INOCULATION ON GROWTH AND NODULATION OF MUNGBEAN

M.M.H. BHUIYAN[1], M.M. RAHMAN[2], F. AFROZE[3], G.N.C. SUTRADHAR[4], AND M.S. I. BHUIYAN[5]

[1]Scientific Officer, RARS, Hathazari, Chittagong, [2]Principle Scientific Officer, SSD, BARI, Joydebpur, Gazipur, [3]Scientific Officer, RARS, Ishurdi, Pabna, [4]Professor, Department of Soil Science, SAU, Dhaka and [5]Lecturer, Department of Soil Science, SAU, Dhaka, Bangladesh

Accepted for publication: June 13, 2008

ABSTRACT

Bhuiyan M.M.H., Rahman M.M., Afroze F., Sutradhar G.N.C., and Bhuiyan M.S.I. 2008. *Effect of Phosphorus, Molybdenum and Rhizobium Inoculation on Growth and Nodulation of Mungbean.* **J .Soil .Nature. 2(2): 25-30**

A pot experiment was conducted during *Kharif*, 2005 at the Soil Science Division, Bangladesh Agricultural Research Institute, Joydebpur, Gazipur. There were four levels of phosphorus (P) (0, 20, 40, 60 kg/ha) and 2 levels of molybdenum (Mo) (1.0 and 1.5 kg/ha) having a common *Rhizobium* inoculant, one control with no *Rhizobium* or fertilization and a *Rhizobium* inoculation only were applied. The performance of *Rhizobium* inoculant alone was superior to control in almost all parameters of the crop studied. *Rhizobium* inoculation along with P and Mo significantly increased the growth of plants, number of nodules, dry matter production as well as grain yield of mungbean significantly compared to uninoculated control. Nodulation (nodule number/plant) was the highest with 20 kg P/ha and 1.0 kg Mo/ha. However, P and Mo application at the rate of 40 kg P/ha and 1.0 kg Mo/ha progressively and significantly increased dry matter content of shoot and root of mungbean. Seed yield/plant was positively correlated with the number of nodules/plant. From this point of view, nodule number/plant with 20 kg P/ha and 1.0 kg Mo/ha, and yield and attributes of mungbean combined application of *Rhizobium* inoculant with 40 kg P/ha and 1.0 kg Mo/ha was considered to be the balanced and suitable combination of fertilizer nutrients for achieving the maximum output through cultivation of mungbean.

Key words: Phosphorus, molybdenum, *Rhizobium*, nodulation and mungbean

INTRODUCTION

Mungbean (*Vigna radiata* L. Wilczek) is one of the major pulse crops grown in Bangladesh. It is one of the major protein rich pulse crop grown principally for both human and animal. Mungbean can supplement the cereal-based diet to improve the nutritional value of food and has a special importance in intensive crop production system of the country for its short growing period (Ahmed *et al*., 1978). In our country, mungbean gives the highest yield under summer planting (Satter and Ahmed, 1995). Fitting them in our usual cropping system and use of seed inoculation with effective *Rhizobium* strains will produce better nodulation, nitrogen (N) fixation, growth and higher yield. N is the most important nutrient element among the major essential elements. For legume, N is more useful because it is the main component of amino acid as well as protein. Adequate supply of nitrogenous fertilizer is essential for normal growth and yield of a crop. The use of biological nitrogen fixation (BNF) technology in the form of *Rhizobium* inoculants in grain legumes can be an alternative of expensive fertilizer, particularly for improving the production of food legumes in the country. Yield increases in mungbean by 10 to 37 % following *Rhizobium* inoculation have been reported by many researchers (Rao, 1980; Satter and Ahmed, 1992). An 18 % increase in nitrogenase activity was reported by Kothari and Saraf (1987) from inoculation of mungbean. The N fixation process is influenced by many factors and P is one of them. Rhizobial activities and N fixation is depressed without proper application of P. It promotes early root formation and the formation of lateral, fibrous and healthy roots, which is very important for nodule formation and to fix atmospheric N. It was reported that application of P along with *Rhizobium* inoculant influenced nodulation and N fixation of legume crops (Solaiman and Habibullah, 1990). Mo application can play a vital role in increasing on the N fixation process by *Rhizobium* and is responsible for the formation of nodule tissue and increase in N fixation (Sharma *et al.,* 1988). So, it is necessary to examine the effects of different levels of those nutrients and assess their best combination in terms of enhanced N fixation and productivity of mungbean. The present study was undertaken to determine the effect of P, Mo and *Rhizobium* inoculants on nodulation and to know the optimum dose of those nutrients on nodulation with *Rhizobium* inoculation.

MATERIALS AND METHODS

The pot experiment was carried out at the 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. The experiment was carried out with mungbean variety BARI mung 5. Each pot was filled with 12 kg of soil. Total amount of urea and 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 in the pots two days before sowing according to the

treatment combinations. The crop was harvested during full maturity. Harvesting was done in two picking within the 20th of May, 2005. From each pot selected plant was collected and then plants were harvested and tied with rope separately and tagged and brought to the threshing floor. All the agronomic practices like weeding; irrigation, mulching, and plant protection measures were performed as and when necessary. Harvesting was done manually. Standard procedures followed for recording and analyzed the data on different yield parameters and means were compared using LSD test at 5% level of significance.

RESULTS AND DISCUSSION

Plant height

The effects of P, Mo and *Rhizobium* inoculant on the plant height of mungbean was found to be positive and significant. The plant height of mungbean ranged from 30.13 to 44.95 cm (Table 1). The highest plant height (44.95 cm) was found with 40 kg P plus 1.0 kg Mo/ha and *Rhizobium* inoculant, which was statistically higher than other treatments. The lowest value 30.13 cm was recorded with the control. *Rhizobium* inoculant alone gave higher plant height (32.12 cm) than the control. Plant height increased with the increasing level of P up to 40 kg. Similar trend was also observed with Mo being highest with 1.0 kg/ha. But P with excess Mo also reduces crop growth. Chemical and biologically fixed N is the most dominating factor influencing the plant height. Muhammad *et al*. (2004) reported that the highest plant height (72.6 cm) was recorded in plot receiving 35 kg P_2O_5/ha + *Rhizobium* inoculum on mungbean. Aghatise and Tayo (1994) reported that Mo application significantly increased plant height of soybean compared with control.

Root length

The effect of different treatments on root length of mungbean was found significant (Table 1). The root length ranged from 6.52 to 11.90 cm. Plants receiving P, Mo with *Rhizobium* inoculant gave higher root length. The highest root length (11.90 cm) was found with P 60 kg/ha and Mo 1.0 kg/ha, which showed 82% higher root length over uninoculated control. *Rhizobium* inoculant alone also gave 30% higher root length over uninoculated control. Similar results were also reported by Solaiman (1999).

Nodulation

Inoculation had a significant positive effect on the formation of nodules. Seed inoculation with *Rhizobium* markedly increased nodule number as compared to that of the non-inoculated plants of mungbean (Table 1). These results are in agreement with Chowdhury and Fujita (1998). They reported that P application at the rate of 60 kg P_2O_5/ha significantly increased nodulation. P application promotes early root formation and the formation of lateral fibrous and healthy roots. Individual effect of P application was pronounced in this study. P at the rate of 40 kg/ha produced highest number of nodule and with increasing P rate nodule number plant was decreased significantly (Figure 1). Among the phosphorus levels, P at the rate of 40 kg/ha and 60 kg/ha, respectively along with 1.0 kg Mo/ha produced significant number of nodules (13.50 and 13.00/plant) at flowering stage (Figure 2). However, mean data showed that the highest nodule/plant was observed with P_{20} (Table 2). Khandaker *et al.* (1985) reported that nodules per plant were increased significantly in blackgram (*Vigna mungo*) due to P application at 40 days after germination. Similar results were reported by Satter and Ahmed (1992). Plant receiving *Rhizobium* inoculation alone or with different levels of P and Mo produced higher number of nodules over uninoculated control. The number of nodules ranged from 6.75 to 13.50 per plant and the increasing trend was recorded upto 40 kg P plus 1.0 kg Mo/ha along with *Rhizobium* inoculation. Sharma *et al.* (1995) reported that seed inoculation with *Rhizobium* and application of 40 kg P_2O_5/ha in chickpea (*Cicer arietinum*) either alone or in combination enhanced nodulation over uninoculated control. Chowdhury and Fujita (1998) found that 50 kg P_2O_5/ha with other fertilizers increased 245% nodule number over control. The effect of Mo alone on total number of nodule per plant was significant (Table 2). From the experiment it was clear that, 1.0 kg Mo/ha produced significantly higher number of nodules per plant than 1.5 kg Mo/ha. The higher number of nodule 12.81 was obtained with 1.0 kg Mo/ha and the number of nodule decreased significantly (11.88) with 1.5 kg o/ha (Table 2). Tiwari *et al.* (1989) also reported that Mo application gave 75% higher nodule number in chickpea.

Number of leaves per plant

Inoculated plants produced significantly higher number of leaves with P and Mo (Table 1). Highest number of leaves (22.84) was found with P and Mo level for 40 and 1.0 kg/ha, respectively which was statistically significant with control (19.27). However, inoculation alone (T_2), or inoculation plus molybdenum (T_3) failed to increase leaves number/plant significantly. It was found that inoculated plants produced higher number of leaves compared to uninoculated plants (19.27).

Number of branches per plant

The significant effect of P, Mo and *Rhizobium* inoculant on branches of mungbean were found (Table 1). It was found that the inoculated plants with P, Mo and *Rhizobium* inoculant had higher number of branches per plant at harvest stage of the crop. The highest number of branches per plant was 5.58 with T_5, but statistically similar with T_6, T_9 and T_{10}. The lowest number of branches 4.40 was obtained in control. It was observed that the higher number of branches was produced by inoculated plants compared to uninoculated control (Table 1). Muhammad *et al.* (2004) found that the number of branches per plant was significantly influenced with both inoculum and P application.

Dry weight of shoot

Significant effect of P, Mo and *Rhizobium* inoculant on shoot dry weight of mungbean was observed (Table 1). The highest shoot dry weight (3.29 g/plant) was recorded in P_{40}+$Mo_{1.0}$+*R* at flowering stage, which was significantly higher than other treatments. At flowering stage T_3, T_4 and T_8 were statistically similar. Molybdenum 1.0 kg/ha performed better than higher dose (Table 1). The lowest dry weight of shoot was recorded in control. *Rhizobium* inoculation increased dry weight of shoot significantly over control. Eusuf Zai *et al.* (1999) showed that *Rhizobium* inoculant significantly increased shoot dry weight of chickpea compared to uninoculated control. Mahmud *et al.* (1997) reported that weight of shoot in lentil significantly increased due to inoculation compared to control. Dry weight of shoot remarkably increased in inoculated mungbean over control as reported by Solaiman (1999).

Dry weight of root

The effect of P, Mo and *Rhizobium* inoculant significantly increased dry weight of root of mungbean compared to control (Table 1). *Rhizobium* inoculant alone and fertilizers along with inoculum produced significantly higher dry weight of root over control. Addition of Mo upto 1.0 kg/ha along with *Rhizobium* inoculant and phosphorus upto 40 kg/ha produced higher dry weight of root and then reduced gradually. Study showed that dry weight of root positively correlated with total number of nodules (Table 3).

Stover yield and seed yield

The effect of phosphorus on stover yield of mungbean was influenced significantly at harvest (Table 2). The highest stover yield (26.38 g) per plant was found with 40 kg P/ha, which was significantly higher than other treatments. With increasing P rate, stover yield decreased significantly. The lowest stover yield was recorded 25.78 g/plant with 0 kg P/ha. Manpreet *et al.* (2004) observed the similar trend in mungbean. Again the single effect of molybdenum on mungbean stover yield was also influenced significantly (Table 2). The stover yields (26.17 g/plant) with 1.0 kg Mo/ha, was significantly higher than the stover yield (25.98 g/plant) recorded with 1.5 kg Mo/ha. Seed yield of mungbean was significantly influenced by different levels of phosphorus (Table 2). The highest seed yield (14.00g) per plant was found with 40 kg P/ha, which was significantly higher than others. The lowest seed yield was recorded in control (10.15 g per plant). Phosphorus at 60 kg P/ha produced the 2nd highest seed yield (12.62g). Yadev and Jakhar (2001) also found similar result on mungbean. Again main effect of Mo on seed yield of mungbean was also significantly influenced (Table 2). The highest seed yield (12.34 g/plant) was found with 1.0 kg Mo/ha and the lowest (11.58 g/plant) was recorded with 1.5 kg/ha. Sfredo *et al.* (1997) also found same results on soybean. Interaction effect of P and Mo also significantly influenced on the seed yield of Mungbean and are presented in Figure 4. The highest seed yield per plant was recorded with P 40 and Mo 1.0 kg/ha. The lowest seed yield per plant was recorded with T_0 and Mo 1.5 kg/ha. In this study seed yield per plant had positive correlation with the number of nodules per plant of mungbean (Table 3 and Figure 3).

The highest plant height, nodules per plant number of leaves, branches per plant, root length were produced by the inoculated plants with P and Mo application at the rate of 40 kg and 1.0 kg/ha, respectively. It was found that highest nodule number per plant was observed with 40 and 1.0 kg/ha P and Mo, respectively. Higher dose of Mo (1.5 kg Mo/ha) did not increase nodule number. The highest root dry weight was found with the treatment P_{60} + $Mo_{1.0}$ + R. Significantly highest seed yield 14.0 (g/plant) was obtained by P application at the rate of 40 kg P/ha and 12.34 (g/plant) was obtained by molybdenum application at the rate of 1.0 kg/ha. The overall result of the experiment suggested that *Rhizobium* inoculation had shown positive effect on nodulation and growth of mungbean. Application of P upto 20 kg/ha increased nodulation and upto 40 kg/ha progressively enhanced growth and yield of mungbean. Application of Mo upto 1.0 kg/ha significantly enhanced nodulation, growth and yield, and at 1.5 kg Mo/ha these parameters decreased significantly. There is enough scope to explore and exploit the production of mungbean in Bangladesh through using *Rhizobium* technology along with phosphorus and molybdenum @ 40 and 1.0 kg/ha, respectively.

Table 1. Effect of phosphorus, molybdenum and *Rhizobium* inoculation on plant height, root length, nodule no., and nitrogen content and uptake by shoot of mungbean

Treatment	Plant height (cm)	Root length (cm)	Nodule number/plant	Leaves no./ plant	Branches no./ plant	Shoot wt. /plant (g)	Root wt. /plant (g)
Control (T_1)	30.13 g	6.52 e	6.75 f	19.27 d	4.40 d	1.55 h	0.25 f
Rhizobium(*R*)(T_2)	32.12 f	8.54 d	11.25 d	19.54 d	4.67 cd	2.22 g	0.28 e
P_0+$Mo_{1.0}$+*R* (T_3)	33.40 def	9.45 cd	11.75 c	19.70 d	4.80 bcd	2.41 ef	0.31 d
P_{20}+$Mo_{1.0}$+*R* (T_4)	34.58 d	8.87 cd	13.00 b	21.37 bc	4.92 bc	2.46 e	0.35 bc
P_{40}+$Mo_{1.0}$+*R* (T_5)	44.95 a	11.84 a	13.50 a	22.84 a	5.58 a	3.29 a	0.40 a
P_{60}+$Mo_{1.0}$+*R* (T_6)	37.49 c	11.90 a	13.00 b	22.90 a	5.54 a	2.94 b	0.38 ab
P_0+$Mo_{1.5}$+*R* (T_7)	32.87 ef	8.70 d	11.75 c	19.70 d	4.77 bcd	2.39 f	0.30 de
P_{20}+$Mo_{1.5}$+*R* (T_8)	33.79 de	9.71 bc	13.00 b	20.71 c	4.88 bc	2.42 ef	0.34 c
P_{40}+$Mo_{1.5}$+*R* (T_9)	41.32 b	10.52 b	11.75 c	21.52 b	5.17 ab	2.77 c	0.37 bc
P_{60}+$Mo_{1.5}$+*R* (T_{10})	36.33 c	11.72 a	11.00 e	22.72 a	5.15 ab	2.68 d	0.36 bc
LSD (0.05)	1.299	0.893	0.247	0.734	0.399	0.052	0.028

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

Table 2. Effect of phosphorus and molybdenum on number of nodule, stover yield and seed yield of mungbean

Nutrients	levels (kg/ha)	No. of nodules/plant	Stover yield/plant (g)	Seed yield/plant (g)
Phosphorus	0	11.75 d	25.78 c	10.15 d
	20	13.00 a	26.01 b	11.00 c
	40	12.63 b	26.38 a	14.00 a
	60	12.00 c	26.13 b	12.62 b
LSD (0.05)		0.166	0.15	0.269
Molybdenum	1.0	12.81 a	26.17 a	12.34 a
	1.5	11.88 b	25.98 b	11.58 b
LSD (0.05)		0.166	0.15	0.269

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

Table 3. Relationship between different crop characters of mungbean

Parameter	Correlation of coefficient (r value)
Number of nodules vs dry weight of shoot	0.81
Number of nodules vs dry weight of root	0.75
Number of branches vs pods/plant	0.78
Number of nodules vs plant height	0.55
Number of nodules vs stover yield	0.92
Number of nodules vs seed yield/plant	0.81
n =40	r value $P_{0.05}$= 0.367 $P_{0.01}$= 0.470

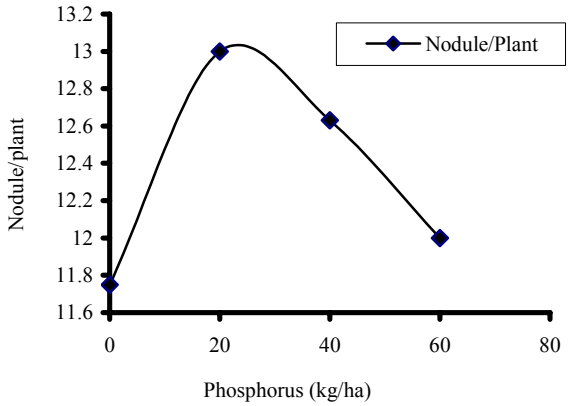

Figure1. Effect of phosphorus application on number of nodules per plant of mungbean

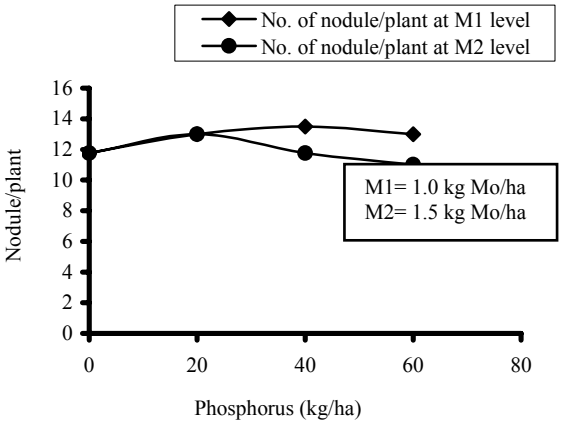

Figure 2. Interaction effect of phosphorus and molybdenum on number of nodule per plant of mungbean

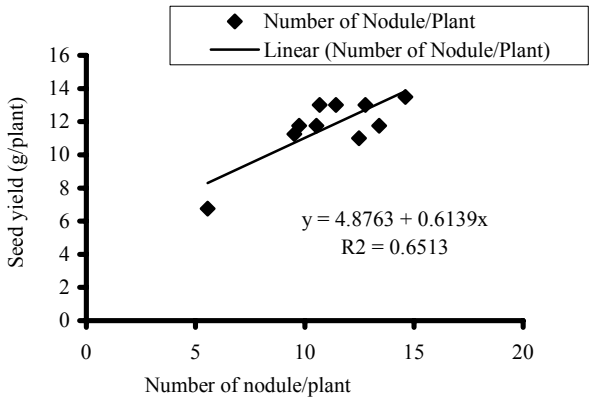

Figure 3. Relationship between nodule number and seed yield of mungbean

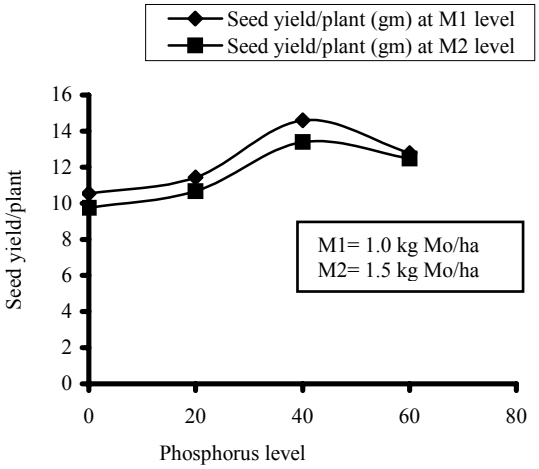

Figure 4. Interaction effect of phosphorus and molybdenum on seed yield of mungbean

REFERENCES

Aghatise, V.O. and Tayo T.O. 1994. Response of soybean to molybdenum application in Nigeria. *Indian J. Agric. Sci*., 64 (4): 597-603

Ahmed, Z.U., Shaikh, M.A.Q., Khan, A.I. and Kaul, A.K. 1978. Evaluation of local, exotic and mutant germplasm of mungbean for varietal characters and yield in Bangladesh. SABRAO *J*. 10: 48

Chowdhury M.I. and Fujita, K. 1998. Comparison of phosphorus deficiency effects on the growth parameters of mashbean, mungbean, and soybean. *Soil Science and Plant Nutrition*. 44: 1, 19-30.

Eusuf Zai, A.K.E., Solaiman, A.R.M. and Ahmed, J.U. 1999. Response of some chickpea varieties to *Rhizobium* inoculation in respect of nodulation, biological nitrogen fixation and dry matter yield. *Bangladesh J. Microbiol*. 16(2): 135-144

Khandakar, U.R., Shinde, D.A., Kandalkak, V.S., Jamley, N.R. and Jain, N.K. 1985. Growth, nodulation and yield of rainfed blackgram (*Vigna mungo* L. Hepper) as influenced by phosphate and sulphur application in vertisol. *Indian J. Plant Physiol*. XXVIII (4): 318-322

Kothari, S.K. and Saraf, C.S. 1987. Nitrate reduction in relation to nitrogenase activity in summer mung (*Vigna radiata*) as influenced by bacterial inoculation and phosphorus application. Current Science.56: 833-836

Mahmud, M.S., Solaiman, A.R.M., Hoque, M.S. and Hashem, M.A. 1997. Influence of *Rhizobium* inoculant and nitrogen on nodulation, growth and N uptake of lentil. *Ann. Bangladesh Agric*. **7**(2): 139-143

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

Muhammad, D., Gurmani, A.H. and Matiullah, K. 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

Rao, N.S.S. 1980. Role of bacteria in crop production. Indian Farming. 30(7):71, 73 & 75

Satter, M.A. and Ahmed, S.U. 1992. Response of mungbean (*Vigna radiata* L.Wilczedk) to inoculation with *Bradyrhizobium* as affected by phosphorus levels. Proc. Commission IV Conference, Bangladesh. 1-3 December, 1992. Pp.419-423

Satter, M.A. and Ahmed, S.U. 1995. Response of mungbean (*Vigna radiata* L. Wilczek) to inoculation with *Bradyrhizobium* as affected by phosphorus levels. Proc. Int. Cong. Coom. IV. pp. 419-423

Sfredo, G.J., Borkerf, C.M., Nepomuceno, A.L., and De. Oliveiva, M.C.N. 1997. Effectiveness of products containing trace elements applied to the seed on yield and protein content of soybean seed. Eficacia de products contendo micronutrients. Field crop Abst. 24(4): 237

Sharma, M.S., Upadhyay, M.S. and Tomar, S.S. 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

Sharma, R.D., Pareck, R.P. and Chandra, R. 1995. Residual effect of phosphate and *Rhizobium* inoculation in chickpea on succeeding maize and fodder sorghum. *J. Indian. Soc. Soil Sci*. 43 (4): 600-603

Solaiman, A.R.M. 1999. Response of mungbean to *Bradyrhizobium sp*. (*Vigna*) inoculation with and without phosphorus and potassium fertilization. *Bangladesh J. Sci. Res*. 17(2): 125-132

Solaiman, A.R.M. and Habibullah, A.K.M. 1990. Response of groundnut to *Rhizobium* inoculation. *Bangladesh J. Soil Sci.* 21 (1): 42-46

Tiwari, B.N., Lehri, K.K. and Pathak, A.N. 1989. *Rhizobium* inoculation of legumes as influenced by phosphorus and molybdenum fertilization. *J. Ind. Soc. Soil Sci*. 37: 712-716

Yadev, B.L. and Jakhar, S.R. 2001. Effect of tillage and phosphorus fertilization on yield and water expense efficiency of rainfed mungbean. *Journal of the Indian Society of Soil Science.* 49: 1, 193-194