Pak. J. Biotechnol. Vol. 14 (2) 189 – 192 (2017) ISSN Print: 1812-1837
www.pjbt.org ISSN Online: 2312- 7791

STUDIES ON DIFFERENT LEVELS OF PHOSPHORUS FERTILIZER AND PHOSPHORUS SOLUBILIZING BACTERIA IN MUNGBEAN (*VIGNA RADIATA* L.)

Niaz Ali Sial[1]*, Shafique Ahmed Abro[2], Muhammad Abbas[1], Muhammad Irfan[1] and Muhammad Yousuf Memon[1]

[1]Soil and Environmental Sciences Division, Nuclear Institute of Agriculture (NIA), Tando Jam, Sindh, Pakistan. Information Technology Cell, Nuclear Institute of Agriculture (NIA), Tando Jam, Sindh, Pakistan. E-mail:* niaz.a.sial@gmail.com

Article received 4.3.2017, Revised 13.6.2017, Accepted 9.6.2017

ABSTRACT

A field experiment on mungbean was conducted in a randomized complete block design (RCBD) with five treatments and three replications. Treatments were T_1 = control, T_2 = 75 kg P/ha, T_3 = *Bacillus polymyxa* @ 25 ml/kg of seed (122 x 10^8 cells/ml); T_4 = 37.5 kg P/ha; T_5 = *Bacillus polymyxa* @ 25 ml/kg of seed (122 x 10^8 cells/ml) + 37.5 kg P/ha. . The results showed that plant height, no. of pods/plant, single plant dry weight, no. of branches/plant, no. of panicles/plant, 100-grain weight, biological and grain yield recorded the highest values in T_2, followed by T_3, T_4 and T_5 respectively. However, the lowest values were observed in control treatment. Total bacterial count was highest (185 x 10^6 and 174 x10^5) at 0-15 and 15-30 cm in T_2 after sowing of crop. Even after crop harvest, T_2 recorded the highest total bacterial count of 181 x 10^4 and 161 x10^4 at 0-15 and 15-30 cm soil depths, respectively. The control treatment showed the lowest bacterial counts at both soil depths after sowing as well as harvesting of crop. It was further revealed that the application of *Bacillus polymyxa* alone contributed at par with T_4 (37.5 kg P/ha) to the most of yield and yield contributing parameters of mungbean crop. Although T_2 was superior to all other treatments, the application of P solubilizing bacterial inocula alone may contribute to mungbean yield potential to some extent in resource poor farming systems.

Keywords: Crop nutrition, Mungbean, Phosphatic fertilizer, P-solubilizers

INTRODUCTION

Use of biological alternatives to synthetic fertilizers has radically increased due to the high costs and environmental concerns associated with later ones (Vance, 2001). Microbial inoculants have proved their worth as biological alternatives to compensate agro-chemicals to sustain environment friendly crop production (Dobbelaere *et al.*, 2003). Various mechanisms involved in plant growth promotion due to these inoculants are N_2 fixation, hormonal regulation, improved nutrient uptake, phosphate solubilization and stress resistance (Sarwar *et al.*, 1992; Arshad and Frankenberger, 1988). Pakistan is an agriculture country producing variety of crops including legumes. Among these, pulses are very important being a major source of protein content. The area under mungbean crop stood at 146.3 thousand hectares and production was around 98 thousand tons (Economic Survey of Pakistan, 2015-16). Phosphorus (P) is a macronutrient that plays a significant role in plant metabolism, ultimately reflecting in crop yield (Theodorou and Plaxton, 1993). Only 10-20% of applied phosphatic fertilizer is recovered during the year of its application and remaining 80% of P becomes insoluble/fixed due to various chemical reactions occurring in soil. Plants cannot access and utilize the fixed P. Phosphate solubilizing microbes (PSM) have potential to solubilize the fixed P and make it available to the plants. Scientists have focused to exploit this microbial potential to increase crop production in resource poor farming systems (Khan *et al.*, 1998). Studies have revealed that inoculation of PSM increased the crop yield by solubilization the soil fixed and applied phosphates (Gull *et al.*, 2004; Sial *et al.*, 2015). Bacteria and fungi such as genera *Bacillus*, *Pseudomonas*, *Rhizobium*, *Aspergillus* and *Penicillium* have potential for P solubilization are commonly present in soil (Rodriguez and Farga, 1999). Asea *et al.* (1988) reported that bacteria such as *Bacillus megatherium* are most effective phosphate solubilizers. PSMs produce low molecular weight organic acids such as gluconic, ketogniconic, glyoxylic, citric, malic and lactic acid to solubilize the inorganic phosphates. Some microorganisms produce the enzymes such as phosphatases which are responsible for P-solubilization from organic sources (Al-Ghazali *et al.*, 1986). The present study was conducted to evaluate the effectiveness of P-solubilizing bacteria on yield performance of mungbean variety AEM 96.

MATERIALS AND METHODS

Field experiment was conducted at Nuclear Institute of Agriculture (NIA), Tando jam, Sindh, Pakistan. The previously isolated P solubilizing bacteria were used for seed inoculation. Phosphate solubilizing bacteria (PSB) (*Bacillus polymyxa*) were re-cultured on pikovskaya`s agar medium for confirmation of their solubilization halo zones. After confirmation, PSB were cultured in nutrient broth for seed inoculation. The final concentration of bacteria was adjusted to $122x10^8$ cells/ml and mungbean seeds were inoculated with the culture @ 25 ml/kg of seed. The experiment was conducted in randomized complete block design (RCBD) with seven treatments and three replications. T_1 = control, T_2 = 75 kg P/ha, T_3 = *Bacillus polymyxa* @ 25 ml/kg of seed (122 x 10^8 cells/ml); T_4 = 37.5 kg P/ha; T_5 = *Bacillus polymyxa* @ 25 ml/kg of seed (122 x 10^8 cells/ml) + 37.5 kg P/ha. At maturity of the crop, the five plants from each middle line of experimental unit were randomly selected and data regarding plant height, number of pods/ plant, single plant dry weight, number of branches/plants, number of panicles/plant, single plant grain yield, 100-grain weight. Biological and grain yield were recorded from each experimental unit. Bacterial counting per gram of soil was done one week after sowing and harvesting of the crop at the depth of 0-15 and 15-30 cm by pore plate method. All the collected data were statistically analyzed using ANOVA and significant differences among treatment means were obtained using least significant difference (LSD) method at 5 % probability level.

RESULTS AND DISCUSSION

The results showed that plant height and single plant dry weight were significantly higher in T_2 (37 cm and 13.64 g) than other treatments, whereas control plots exhibited lowest plant height as well as single plant dry weight (31 cm and 8.45 g) (Table 1). Plots sown under treatment T_3 (seed inoculated with *Bacillus polymyxa*) produced plants of identical height and single plant dry weight when compared with plots having T_4 and T_5. T_2, T_3 and T_4 had statistically identical effect on no. of pods/plant and no. of panicle/plant followed by T_5 and control treatment. No. of branches per plant were also highest in T_2, followed by T_3 and T_4, T_5 and control in descending order. Single plant grain yield and 100-grain weight were highest in T_2 (3.94 and 4.80g), whereas non-significant difference was found between T_3 and T_4. Control plots produced lowest single plant grain yield and 100-grain weight (2.60 and 1.80 g, respecttively). Application of 75 kg P/ha (T_2) produced higher biological and grain yield (2541 and 782 kg/ha) than any other treatment. T_2 and T_3 were statistically at par for their effect on biological and grain yield (Table 2). Bacterial enumeration /gram of soil at 0-15 and 15-30 cm depth was significantly higher in T_2 one week after sowing and harvesting of the mungbean crop (Table 3).

Table 1: Influence of different treatments on growth and yield associated characteristics of mungbean

Treatments	Plant height (cm)	No. of pods/plant	Single plant dry wt. (g)	No. of branches /plant	No. of panicles / plant
T_1 = control	31 C	10 C	8.45 C	1.0 D	1.0 C
T_2 = 75 kg P/ha	37 A	15 A	13.64 A	5.0 A	6.0 A
T_3 = *B. polymyxa* @ 25 ml/kg of seed ($122x10^8$ cells/ml)	34 B	14 A	10.29 B	4.0 B	5.0 AB
T_4 = 37.5 kg P/ha	34 B	14 A	10.29 B	4.0 B	5.0 AB
T_5 = *B. polymyxa* + 37.5 kg P/ha	33 B	12 B	9.31 B	3.0 C	5.0 AB
$LSD_{0.05}$	**1.02**	**1.26**	**0.01**	**0.93**	**1.15**

Table 2: Influence of different treatments on yield parameters of mungbean

Treatments	Single plant grain yield (g)	100-grain weight (g)	Biological yield (kg/ha)	Grain yield (kg/ha)
T_1 = control	2.6 D	1.8 D	1391 D	279 D
T_2 = 75 kg P/ha	3.94 A	4.80 A	2541 A	782 A
T_3 = *B. polymyxa* @ 25 ml/kg of seed ($122x10^8$ cells/ml)	3.50 B	3.72 B	2391 B	674 B
T_4 = 37.5 kgP/ha	3.49 B	3.71 B	2391 B	676 B
T_5 = *B. polymyxa* + 37.5 kg P/ha	3.29 C	2.91 C	2021 C	518 C
$LSD_{0.05}$	**0.22**	**0.01**	**2.28**	**2.7**

Table 3: Bacterial count per gram of soil at the depth of 0-5 and 15-30 cm after one week of sowing and harvesting of crop

Treatments	After one week of crop sowing		After one week of crop harvesting	
	0-15cm depth	**15-30 cm Depth**	**0-15cm depth**	**15-30 cm depth**
T_1 = control	$120x10^3$ D	$111x10^2$ D	$101x10^2$ D	$80x10^2$ D
T_2 = 75 kg P/ha	$185x10^6$ A	$174x10^5$ A	$181x10^4$ A	$161x10^4$ A
T_3 = *B. polymyxa* @ 25 ml/kg of seed ($122x10^8$ cells/ml)	$170x10^5$ B	$169x10^4$ B	$160x10^4$ B	$140x10^3$ B
T_4 = 37.5 kg P/ha	$170x10^5$ B	$169x10^4$ B	$160x10^4$ B	$140x10^3$ B
T_5 = *B. polymyxa* + 37.5 kg P/ha	$150x10^5$ C	$141x10^4$ C	$140x10^3$ C	$125x10^2$ C
$LSD_{0.05}$	**8.18**	**2.96**	**1.66**	**3.15**

Treatment T_3 in which seeds were inoculated with *Bacillus polymyxa* was statistically at par with T_4 (37.5 kg P/ha) regarding its effects on almost all growth and yield parameters of mungbean which imply that P-solubilizers inocula have potential to mobilize soil indigenous P pool and make it available to the plants for their growth and development. Sial *et al.* (2010; 2016) have reported similar results while studying the effects of *Bacillus megatherium* inoculation on mungbean growth and yield. Inoculation with *Bacillus megatherium* var: *phosphaticum*, like phosphorus dissolvent, play a significant role in increasing available phosphorus level of soil (Sahran and Nehra, 2011). Further, phosphorus helps in N-fixation and root nodulation, and increases no. of pods/plant, 100-grain weight, seed yield and water use efficiency (Jain *et al.*, 1999). Application of bacterial inoculants has resulted in significant improvement of plant growth and crop yield (Gull *et al.*, 2004). A majority of the isolated organisms from the soil are bacteria, although several fungi are also known to solubilize phosphates. These bacteria and fungi have the potential to be used as biofertilizer and cab play important role in increasing crop yield of cereals, legumes, fibers, vegetables, oil crops and other crop plants (Kundu *et al*., 2009). Our study concluded that PSBs can be effectively used to obtain subsistent crop yield in resource poor farming systems of Pakistan where phosphatic fertilizers are costly and usually the farmers have poor purchasing power as well as access to P fertilizers.

REFERENCES

Al-Ghazali, M.R., M.S.H. Khorshed, K. Khorshed and Al-Azawi, Some observation on phosphorus solubilization by aerobic microorganisms isolated from sediments of Al-Khari River Bhaghdad. J. Biol. Sci. Res. 17: 157-172 (1986).

Arshad, M., and W.T. Farankenberger, Plant growth regulating substances in rhizosphere: Microbial production and function. Adv. Agron. 62: 46-51 (1988).

Asea, P.E.A., R.M.N.Kusey and J.W.B. Stewart, Inorganic phosphate solubilization by two *Penecillium* species in solution culture and in soil. Soil Biol. Biochem. 20(4): 459-464. (1988).

Dobbelaere, S.J., Vanderleydern and Y. Okon, Plant growth-promoting effects of diazotraphs in the rhizosphere. Crit. Rev. Plant Sci. 22 (2):107-149 (2003).

Economic Survey of Pakistan. 2015-2016. Ministry of Finance, Government of Pakistan, Islamabad.

Gull, M., F.Y. Hafeez, M. Saleem and K.A. Malik, Phosphorus uptake and growth promotion of chickpea by co-inoculation of mineral phosphate solubilising bacteria and a mixed rhizobial culture. Anim. Prod. Sci. 44(6): 623-628 (2004).

Jain, P.C., P.S. Khushawaha, U.S Dhakad, H. Khan and S.K. Trivdi, Response of chickpea (*Cicer arietinum*) to phosphorus and biofertilizer. Legume Res.12 (4): 241-244 (1999).

Khan, M.S., M. Aamil and A. Zadi, Mungbean response to inoculation with nitrogen fixing and phosphate solubilizing bacteria. In: A.M. Deshmukh (ed.), Biofertilizers and biopesticides, Technoscience Publications, Jaipur. P. 40-48 (1998).

Kundu, B.S., K. Nehra, R. Yadav, Biodiversity of phosphate solubilizing bacteria in rhizosphere of chickpea, mustard and wheat grown in different region of Haryana. Ind. J. Microbiol. 49: 102-127 (2009).

Rodriguez, H. and R. Fraga, Rhizobial phosphate solubilizing bacteria and their role in plant growth promotion. Biotechnol. Adv. 17: 319-339 (1999).

Sahran, B.S. and V. Nehra, Plant growth promoting rhizobacteria: a critical review. Life Sci. Med. Res. 21:1-30 (2011).

Sarwar, M., M. Arshad, D.A. Martens and W.T. Frankenberger, Tryptophan dependent biosynthesis of auxins in soil. Plant and Soil 147(2): 207-215 (1992).

Sial, N.A., M.Y. Memon, M.A. Arain and J.A. Shah, Phosphobacterial inoculation and different doses of P fertilizer for increasing yield and yield components of mungbean (*Vigna radiata* L.). Pak. J. Biotechnol. 7(1-2): 117-121 (2010).

Sial, N.A., M.Y. Memon, S.A. Abro, J.A. Shah, N.D. Depar and M. Abbas, Effect of phosphate solubilizing bacteria (*Bacillous megatherium*) and phosphate fertilizer on yield and yield components of wheat. Pak. J. Biotechnol. 12(1): 35-40 (2015).

Sial,N.A., S.A.Abro, J.A.Shah and M.Y.Memon, Response of different doses of phosphate fertilizer and phosphate solubilizing bacteria and mycorrhizae in mungbean (*Vigna radiata* L.). Pak. J. Biotechnol. 13(1): 73-77 (2016).

Teodorou, M.E. and W.E. Plaxton, Metabolic adaptations of plant respiration to nutrition phosphate deprivation. Plant Physiol. 101: 339-344 (1993).

Vance, C.P., Symbiotic nitrogen fixation and phosphorus acquisition. Plants nutrition in a world of declining renewable sources. Plant Physiol. 127(2): 390-397 (2001).