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PHOSPHOBACTERIAL INOCULATION AND DIFFERENT DOSES OF P FERTILIZER FOR INCREASING YIELD AND YIELD COMPONENTS OF MUNG BEAN (*VIGNA RADIATA* L.*)*

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ABSTRACT

Studies were conducted to assess the significance of phosphobacterial inoculation in mungbean variety AEM-96. Different levels of phosphorus fertilizer, phosphobacterial inoculum alone and combination of phosphate fertilizer with phosphobacteria were used. Grain yield and yield components viz., biological yield, plant height, pods per plant, 100 grain weight, days to flowering and days to maturity were studied. The data on microbiological counts were recorded in the soil after one week of sowing and after harvesting of crop at the depth of 0-15 and 15-30 cm. A field experiment was laid out in RCBD with five treatments in four replications at experimental farm of Nuclear Institute of Agriculture (NIA) Tando Jam, Sindh. The results showed that the biological yield and grain yield were significantly increased at T2 (75 kg P h^{-1}) followed by T3 (37.5 Kg P h^{-1}) and T4 (phosphor-bacteria 25 ml Kg^{-1} of seed). Non significant difference between T3 and T4 were observed. Same trend was observed for 100-grain weight, plant height and number of pods per plant. Significant increase in phosphobacteria was observed in T4 as compared to other treatments after sowing and after harvesting of crop. It is obvious from the results that the phosphorbaterial inoculation alone could be used to get a reasonable yield from mungbean and could be more economical for the growers.

INTRODUCTION

Pakistan is an agriculture country producing variety of crops including legumes. Among these, pulses are important being a major source of protein content for the masses. Mungbean *Vigna radiata* L. is an important pulse crop in many Asian countries including Pakistan, where the diet is mostly cereal based. The area under mungbean crop in Pakistan is 247.4 thousand hectares and production around 177.7 thousand tons (Anonymous, 2008). The average grain yield of mungbean is very low due to non availability of higher yielding varieties, poor agronomic management practices, and lack of proper nutrient management. There is a high requirement of phosphorus by legumes as it has pronounced effect on root development, straw strength, crop quality and yield (Balnchandran and Sasidhar, 1991). They found that the mean seed yield of mung bean was 0.36, 0.42, 0.51, and 0.54 t^{-h} with 0, 15, 30, and 45 kg P_2O_5 h^{-1} respectively. This practice of artificial inoculation has been proven best for improving the yield of legumes, especially in soil lacking its effective *Rhizobium* (Khan *et al.*, 1977; Khan *et al.*, 1987). Phosphorus is required for normal functioning of N_2 fixing bacteria and weight of effective nodules on the root system of leguminous crops (Brady, 1984; Khan and Khan 1986; Ranjha *et al.*, 1989). In recent years, free living soil bacteria are commonly used as inoculants in various parts of the world for improving the yield of agriculture crops. These bacteria, when applied to seeds or roots, colonize plant roots and stimulate plant growth and crop yield by multifarious mechanisms ranging from direct influence (e.g. increasing solubilization and uptake of nutrient, production of plant growth regulators) to an indirect effect (e.g. pathogen suppression such as biocontrol, and production of antibiotics) . These have been termed as plant growth promoting rhizobacteria (PGPR) (Bianica *et al.*, 2001). Present studies were therefore conducted to observe the role of phosphobacteria in the improvement of yield and yield components of mungbean.

MATERIALS AND METHODS

The field studies were conducted on mungbean variety AEM-96 evolved by Nuclear Institute of Agriculture (NIA) Tando Jam. Pre-isolated phosphate solubilizing bacteria *Bacillus megatherium* var. *phosphaticum* were obtained from experimental farm of Nuclear Institute of Agriculture (NIA) Tando Jam Sindh. Phosphobacterial strain was sub-cultured on the fresh calcium phosphate media for further confirmation. On this media the phosphobacteria showed the zones around the colonies. After confirmation the colony of *phosphobacteria* inoculated in to the 25 ml of calcium phosphate broth and incubated for 24 hours on the temperature 35ºC. After incubation the 25 ml of inoculum was inoculated in to the 1kg of mungbean seed for sowing. The experiment was conducted in randomized complete block design (RCBD) with four replications and five treatments. The treatments were T_1= control, T_2 = 75kg triple super phosphate/ha, T_3= 37.5kg triple super phosphate/ha, T_4 = phosphor-bacteria 10^8cells/ml, (25 ml/kg of seed) and T_5= phosphobacteria + 37.5 kg triple super phosphate/ha. Randomly five plants were selected from each middle line. The data regarding to plant height, number of pods/plant, biological yield kg/ha were recorded. Microbial counting was done after one week of sowing and after harvesting of the crop at the depth of 0-15 and 15-30 cm. Data were subjected to analysis of variance and D'MR test for comparison of means.

RESULTS AND DISCUSSION

The results showed that the biological yield and grain yield of mungmean variety AEM-96 were significantly increased at T2 (75 kg P/ha) followed by T3 and T4 (37.5kg P/ha) and phosphobacteria 10^8 cells/ml respectively). Non significant difference between T3 and T4 were observed. Same trend was observed for 100 grain weight, plant height and number of pods per plant. Significant increase in Phosphobacteria was observed in T4 treatment as compared to other treatments before sowing and after harvesting of crop. It is obvious from the results that the phosphobaterial inocu-lation alone could be used to get a reasonable yield from mungbean. It could be more economic for the growers. Percent increase in yield due to different treatments was calculated as compared to control. The highest increases in yield (172%) were observed at T2 than all other treatments as compared to control followed by T3 and T4 treatments (128 and 127% respectively). T5 showed less (54%) increase in yield as compared to control.

Data regarding in plant height the treatment 75 kg TSP h^{-1} was significantly higher than other treatments. Treatments such as 37.5 kg TSP h^{-1}, phosphobacteria and phosphobacteria + 37.5 kg TSP h^{-1} were also significantly different from control, whereas the control was lowest in plant height. Several workers have reported that the seed inoculation with *Rhizobium* has significantly increased the growth and yield of legumes crop (Goel *et al.,* 1999, Pathak *et al.,* 2001). Data recording to number of pods/plant showed that the treatment 75 kg TSP h^{-1} was significantly higher than other treatments, there was not significantly different in the treatment 37.5kg TSP h^{-1} and phosphor-bacteria. It was recorded that the treatment phosphobacteria + 37.5kg TSP h^{-1} was higher than control and lower than other treatments. A similar pattern for grain yield increased with N and P or P with inoculation has been observed by (Raza *et al.,* 2004; Hussain *et al.,* 1996).

It was found that the 100-grain weight in treatment 75 kg TSP h^{-1} was increased than other treatments, whereas phosphor-bacterial and 37.5 kg TSP h^{-1} was similar with each other. The treatment phosphor-bacterial + 37.5 kg TSP h^{-1} showed higher 100 grain weight than the control treatment, but lower than 75 kg TSP h^{-1} and phosphobacterial alone treatment. In grain yield, the treatment 75 kg TSP h^{-1} showed the highest grain yield (683.75 kg h^{-1}). Whereas, the grain yield of the treatment 37.5 kg TSP h^{-1} was identical to phosphobacterial treatment and signify-cantly higher than control.

Treatment 37.5 kg TSP h^{-1} + phosphor-bacteria showed the grain yield lower than other treatments but significantly higher from control (Table-1). While phosphorus helps in nitrogen fixation and increase inoculation, pods per plant, 100 grain weight, seed yield and water use efficiency (Saini and Faroda, 1998, Jain *et al.,* 1999). It is amolecular dialogue between the host and a compatible strain of *Rhizobium,* which serve as an initiate or of the development of vacules (Murray *et al.,* 2007). Application of bacterial inoculants as biofertilizer has resulted in improved plant growth and increased yield of cereal crops (Shah *et al.,* 1996, Bodd *et al.,* 1986, Periera *et al.,* 1988, Kennedy and Tchan 1992, Bhandari and Somani, 1990). The data showed that days to flowering and days to mature of the crop that the treatment 75 kg TSP h^{-1} was similar with phosphobacteria + 37.5 kg TSP h^{-1} and treatment 37.5 kg TSP h^{-1} was also same as the treatment of phosphor-bacterial alone. Whereas, the control showed the days to flowering were highest in all the treatments. Another character of the crop is the days to mature. In this observation the treatment 37.5kg TSP h^{-1} and phosphor-bacteria were similar. The treatment phosphobacteria + 37.5kg TSP h^{-1} showed the higher number of days for mature of the crop from other treatments except control. Whereas, the treatment 75 kg TSP h^{-1} showed the lowest number of days for maturity of the mungbean crop. It was noted that the control showed the highest number of days for maturity of crop (Table 2).

The result showed that the micro-organisms after sowing of one week in one gram of soil at the depth of 0-15 and 15-30cm was highest in the treatment of 75 kg TSP h^{-1} and in the treatment 37.5 kg TSP h^{-1} and phosphorbacterial treatment the microorganisms were similar. Whereas, the treatment phosphor-bacteria + 37.5 kg TSP h^{-1} was lower than other treatments except control. It was observed that the control showed the lowest number of microorganism in one gram of soil at the depth of 0-15 and 15-30 cm (Table 3).

Table-2: Phenological traits of mungbean as affected by various treatments phosphorus and phosphobacterial inoculum

Treatments	Days to flower	Days to mature
T1= Control	45.00 a	67.00 a
T2= 75 kg P h^{-1}	43.00 c	63.00 d
T3= 37.5 kg P h^{-1}	44.00 b	64.00 c
T4=phosphobacteria 25 ml kg^{-1} of seed	44.00 b	64.00 c
T5=phosphobacteria +37.5 kg P h^{-1}	43.00 c	65.00 b

Table -3: Microorganisms (phosphor bacteria) in soil after one week of sowing of mungbean at the depths of 0-15 cm and 15-30 cm

Treatments	**0-15 cm**	**15-30 cm**
T1= Control	$167x10^4$ d	$128x10^3$ d
T2= 75 kg P h^{-1}	$200x10^6$ a	$178x10^5$ a
T3= 37.5 kg P h^{-1}	$195x10^6$ b	$165x10^5$ b
T4=phosphobacteria 25 ml kg^{-1} of seed	$196x10^5$ b	$164x10^4$ b
T5=phosphobacteria +37.5 kg P h^{-1}	$185x10^5$ c	$144x10^4$ c

The result showed that the microbial counts in one gram of soil at the depth of 0- 15 and 15- 30 cm, after harvesting of crop. The treatment 75 kg TSP h^{-1} was the highest in number of microorganisms in one gram of soil compared with other treatments. Treatment 37.5 kg TSP h^{-1} and phosphobacterial treatment were similar and significantly different from control. Whereas the treatment phosphobacteria + 37.5 kg TSP h^{-1} was lower than other treatments and higher than control (Table -4). Many workers reported that i) improved germination by 30%, ii) 16-30% increased in yield, iii) higher population of *Azotobacter* in rhizosphere of wheat as result of *Azotobacter* inoculation in wheat.

Table-4: Microorganisms (phosphor-bacteria) in soil after one week of harvesting of mungbean at the depths of 0-15 cm and 15-30 cm

Treatments	**0-15 cm**	**15-30 cm**
T1= Control	$126x10^3$ d	$120x10^2$ d
T2= 75 kg P h^{-1}	$176x10^5$ a	$171x10^4$ a
T3= 37.5 kg P h^{-1}	$170x10^5$ b	$160x10^4$ b
T4=phosphobacteria 25 ml kg^{-1} of seed	$169x10^4$ b	$161x10^3$ b
T5=phosphobacteria +37.5 kg P h^{-1}	$160x10^4$ c	$150x10^3$ c

Table- 1: Response of phosphobacteria for grain yield and yield associated characteristics of mungbean variety AEM-96

Treatments	**100-grain weight (g)**	**Plant height (cm)**	**No: of pods/ plant**	**Biological yield (kg/ha)**	**Grain yield (kg/ha)**
T1= Control	1.59 d	30.95 c	8.56 d	1250 d	251.25 d
T2= 75 kg P h^{-1}	4.2 a	34.10 a	12.0 a	2337.5 a	683.75 a
T3= 37.5 kg P h^{-1}	3.9 b	32.40 b	11.40 b	2187.5 b	573.75 b
T4= hosphobacteria 25 ml kg^{-1} of seed	3.7 b	32.41 b	11.38 b	2175.0 b	571.25 b
T5= hosphobacteria +37.5 kg P h^{-1}	2.1 c	32.4 b	10.20 c	1875 c	387.5 c

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