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Management of Phosphorus Fertilizer in Maize Crop using PSB (*phosphorus solubilising bacteria*) in Vertisol

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ABSTRACT

Phosphorus is a second most important nutrient in soil for crop production and there is no large atmospheric source that can be made biologically available. Large amount of P applied as fertilizer (DAP, SSP, DSP and TSP etc) enters in to the immobile pools through precipitation reaction with highly reactive Al^{3+} and Fe^{3+} in acidic condition, and Ca^{2+} in calcareous or normal soil. A field experiment was conducted at farmer field, during kharif season with different treatments of PSB combination of different fertilizers. The results of this study showed that the application of PSB with phosphoric fertilizer gave higher effects on growth and yield of maize. PSB increase the solubility of phosphate in soil and enhance the plant growth by improving biological fixation. Application of PSB will help in reducing the 30-40 % conception of P fertilizer. In environmental point of view, control soil and water pollution and also balance the physical, biological and chemical soil fertility with application of low P fertilizer and PSB.

Key words: *Phosphorous, PSB, Fertilizer, Biofertilizer, Vertisol*

INTRODUCTION

Phosphorus is a second most important nutrient in soil for crop production and there is no large atmosheric source, which can be made biologically available[1]. The main role of P to plant is root development, stalk and stem strength, flower and seed formation, crop maturity and production. It has a deferent role in plant metabolism such as cell division, development, photosynthesis, breakdown of sugar, nuclear transport within the plant, transfer the genetic characteristics from one generation to another and regulation of metabolic pathway. The phosphorous content in average soil is ab 0.05% (w/w) but only 0.1% of the total phosphorous is available to plant because of fixation and poor solubilit in soil[2]. The phosphorus available for plant growth depends not only on the total amount of phosphorus in the soil but also on its solubility. Large amount of P applied as fertilizer (DAP, SSP, DSP and TSP etc) enters in to the immobile pools through precipitation reaction with highly reactive Al^{3+} and Fe^{3+} in acidic, and Ca^{2+} in calcareous or normal soils[3,4].

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Microorganisms with phosphate solubilizing potential increase the availability of soluble phosphate and enhance the plant growth by improving biological fixation[5,6]. Some bacterial species have solubilization and mineralization potential for inorganic and organic phosphorus, respectively[7]. Application of PSB will help in reduced the conception of P fertilizer and also reduced the cast of cultivation of farmers.

MATERIAL AND METHODS

Field Experiment

A field experiment was conducted at farmer field, during kharif season of the year 2016. The geographical location of the site is situated between 22°09'40.77" N and 76°04′42.46 E with an altitude of 641 m above the mean sea level. The average annual rainfall is nearly 910 mm. The soil of the experimental area was classified as typic Haplustert sub group of "vertisol". The soil of the area has medium depth, black colour and clay loam texture and sandy clay loam in texture, alkaline in reaction.

The experiment consisted of eight treatments viz. T-1 Control, T-2 PSB, T-3 NK (100%), T-4 NK (100%) + PSB, T-5 NK (100%) + 50% P (SSP), T-6 NK (100%) +50% P (SSP) + PSB, T-7 NPK (100%), and T-8 NPK (100%) + PSB were tested in RBD (randomized block design) with three replications. The entire field was divided into micro plots of equal size (2 m x 1.5 m) and all the treatments were randomly allocated to different plots in each replication. Sowing hybrid maize (Pioneer 30V92) was done uniformly in all the plots with at 45 cm row to row and 30 cm plant to plant spacing manually on 30/06/2016. Recommended fertilizer dose 120-60-40 kg N, P_2O_5, K_2O per hectare was applied through Urea, SSP and MOP (KCl) respectively, Recommended PSB dose 8 kg per ha were applied. Application of 'N' in three split doses - 60kg as basal, 30 kg at knee high stage and 30 kg at flowering stage. FYM @ 1t/ha uniform to all plots i.e. 300 g FYM/plot as basal. The crop was harvested at 105 days. After harvesting the crop, plant Samples (grain and shoot) were collected and successively dried at 70 °C to a constant weight.

Soil Sample Collection

Soil sample was collected from experimental field for pre physicochemical parameter and available phosphorous analysis.

Soil Sample Processing

Soil Samples were completely air-dried and passed through 2 mm sieve and stored in properly labeled in plastic bags for pre analysis.

PSB (Bio-fertilizer)

Freshly prepared Bio-fertilizer of PSB with (Lignite based) was purchased at BPD unit, JNKVV (Jawaharlal Nehru Krashi Vishvavidhalaya), Jabalpur (M. P.).

Physicochemical Analysis of Soil

The soil pH and EC was determined in 1:2.5, soil: water suspension[5]. Organic matter was determined by wet oxidation method[9]. Cation exchange capacity (CEC) was calculated by the summation of exchangeable acidity and bases[10]. The available P of soil was analyzed with sodiumbicarbonate method[11]. Total phosphorus of root and shoot of maize was measured by digestion method[12].

RESULTS AND DISCUSSION

A perusal of the data presented in the Figure- 2 and 3 clearly indicated that biomass yield (grain and stover) were significantly affected by the application PSB with deferent combination of fertilizers. The soil treated with PSB (no any fertilizer) were recorded highest grain and stover yield (3.97 t/ha and 5.41 t/ha) as compared to the control (3.12 t/ha and 5.26 t/ha), which was 27% and 3% more over the control (Fig-1). Many research also applied phosphorus solubilizing bacteria (PSB) with NPK fertilizers in wheat crop and they reported that yield was 2.63 t/ ha in control, 3.41 t/ ha with NPK only and the highest (3.80 t/ ha) with NPK+PSB [13]. There was no difference in the agronomic parameters of T-4 (NK 100% + PSB) and T-5 (NK 100% + 50% P) (Plate-7) similar to T-6 (NK 100% + 50% P + PSB) and T-7 (NPK 100%) treated plant (Fig- 2,3,4 and 5). The phosphate solubilizing potential is increase with application of PSB[6].

Biomass yield and agronomic parameters of maize grown in without PSB treatments were significantly lower than treated of soil with PSB. Higher crop yields result from solubilization of fixed soil P and applied phosphates by PSB[14,15]. There was decreased grain yield and size of cobs in plots which no treated with PSB. The highest straw yield was obtained with phosphate solubilizing bacteria[16]. The conjunction of PSB with single super phosphate and rock phosphate reduces the P dose by 25 and 50 %, respectively[17]. The P content was increased with application of PSB both grain and stover compeer to control (Fig-4 and 5). Phosphorus content was significantly increased of cotton plant with Bacillusmeliloti combined with phosphorus as compared to uninoculated plants growing in the control soil[18]. Similar findings about the increase in P-uptake by wheat plant due to PSB inoculation was reported[19].

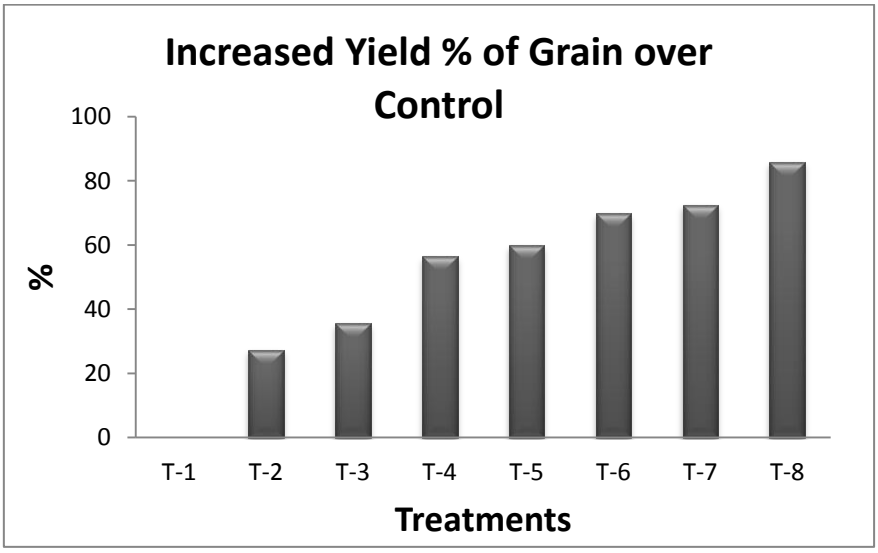

Fig. 1: Increased Yield % of Grain over Control (Maize)

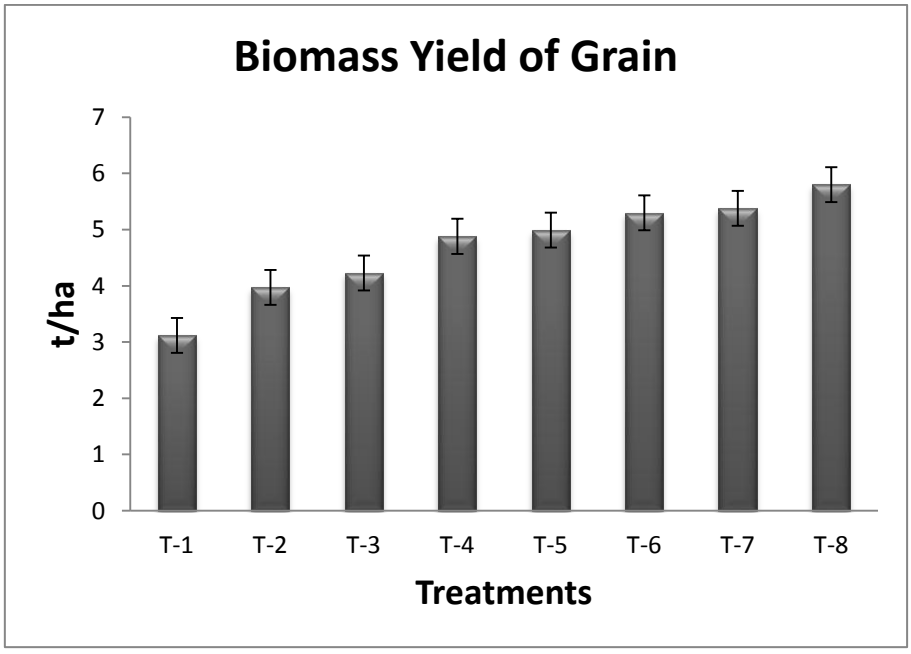

Fig. 2: Biomass of Grain (Maize)

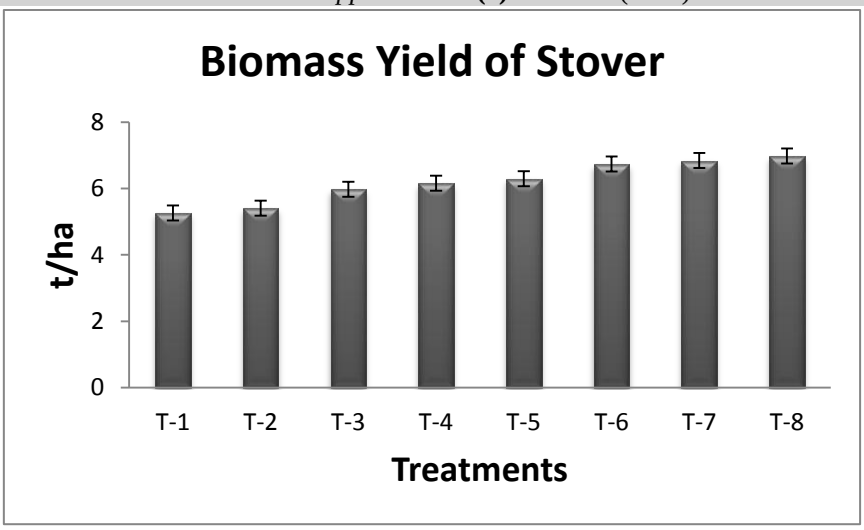

Fig. 3: Biomass of Stover (Maize)

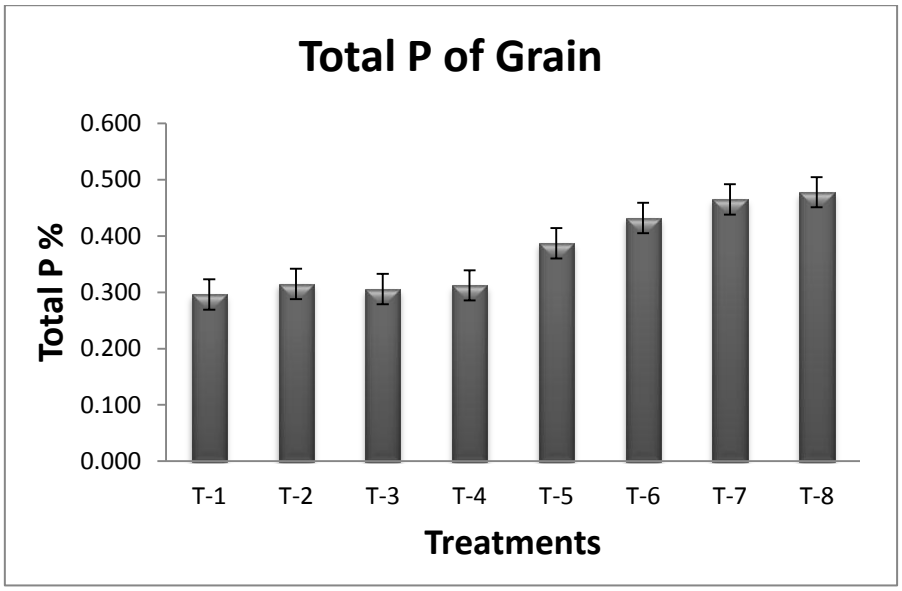

Fig. 4: Total P content of Grain (Maize)

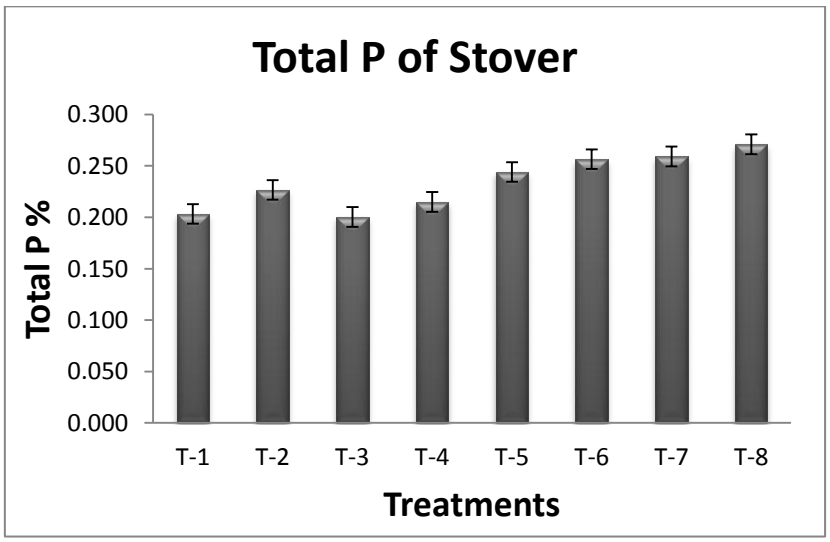

Fig. 5: Total P content of Stover (Maize)

Table 1: Physicochemical parameter of experimental soil

S. No.	Parameter	Value
1	pH	7·72
2	EC dms	0·92
3	Organic Carbon (%)	0·60
4	Available Phosphorus (kg/ha)	12·6
5	Cation exchange capacity (CEC) (cmol (p+)/kg)	43.3

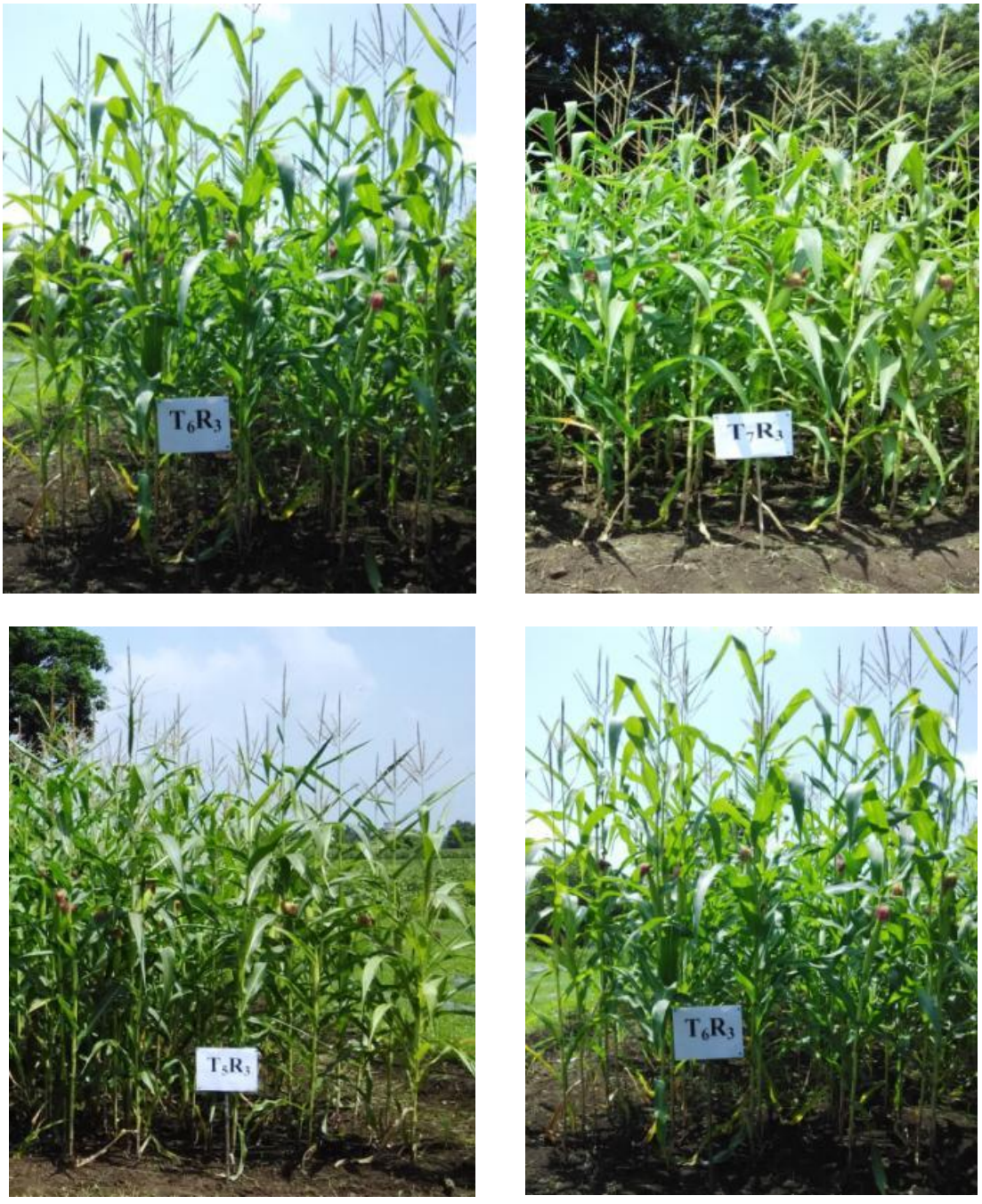

Plate 1: Comparison between T-6 (NPK 100%), T-7(NK 100% +50%P +PSB), T-5 (NK 100% +50%)

CONCLUSION

The results of this study showed that the application of PSB with phosphoric fertilizer gave higher effects on growth and yield of maize. PSB increase the solubility of phosphate in soil and enhance the plant growth by improving biological fixation. Finally, Application of PSB will help in reduced the

conception of P fertilizer and also reduced the cast of cultivation of farmers. In environmental point of view, control soil and water pollution and also balance the physical, biological and chemical soil fertility with application of low P fertilizer and PSB.

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