

Original Research Article

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## Influence of Phosphorus and Biofertilizers on Soil Fertility and Enzyme Activity of Soils Grown under Mungbean [*Vigna radiata* (L.)Wilczek]

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### ABSTRACT

#### Keywords

Mungbean,  
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A field experiment was conducted during *kharif* season of 2015 on loamy sand soil at the Agronomy farm, S.K.N. College of Agriculture, Jobner (Rajasthan) which consisted of four levels of phosphorus (Control, 20, 40 and 60 kg P<sub>2</sub>O<sub>5</sub> ha<sup>-1</sup>) and four levels of biofertilizers (Control, PSB, *Aspergillus awamori* and PSB + *Aspergillus awamori*) thereby, making sixteen treatment combinations and replicated thrice. The results indicated that application of phosphorus upto 40 kg P<sub>2</sub>O<sub>5</sub> ha<sup>-1</sup> recorded significantly highest organic carbon, available nitrogen, available potassium, dehydrogenase enzyme activity and alkaline phosphatase activity in soil after harvest which was at par with 60 kg P<sub>2</sub>O<sub>5</sub> ha<sup>-1</sup>. Available phosphorus status of soil was recorded significantly maximum with the application of 60 kg P<sub>2</sub>O<sub>5</sub> ha<sup>-1</sup>. Results further indicated that seed inoculation with the PSB and *Aspergillus awamori* significantly increased organic carbon, available nitrogen, available potassium, dehydrogenase enzyme activity and alkaline phosphatase activity in soil after harvest over the rest of the treatments.

### Introduction

Pulses are important source of dietary protein and have unique ability of maintaining and restoring soil fertility through biological nitrogen fixation as well as addition of ample amount of residues to the soil. Pulse crops leave behind reasonable quantity of nitrogen in soil to the extent of 30 kg ha<sup>-1</sup>. Mungbean [*Vigna radiata* (L.)Wilczek] is one of the important pulse crop grown in arid and semi-arid regions in India. It is a short duration pulse crop which can be grown as catch crop during *kharif* and *rabi* seasons. Phosphorus is an important nutrient next to nitrogen.

At present 5% of the Indian soils have adequate available P, 49.3% are under low category, 48.8% under medium and 1.9% under high category (Pattanyak *et al.*, 2009). Only 25% to 30% of the applied P is available to crops and remaining P is converted into insoluble P (Sharma and Khurana, 1997). Its deficiency is the most important single factor, which is responsible for poor yield of mungbean on all types of soil. It is indispensable constituent of nucleic acids, ADP and ATP. It has beneficial effects on nodule stimulation, root development and growth and also hastens maturity as well as

improves quality of crop produce. Thus, the response of P to legumes is more important than N as later is being fixed by symbiosis with *Rhizobium* bacteria.

Biofertilizers, a component of integrated nutrient management and are considered to be cost effective, eco-friendly and renewable source of non-bulky, low cost plant nutrient supplementing fertilizers in sustainable agriculture system in India.

Therefore, the role of biofertilizers assumes a special significance in present context of very high costs of chemical fertilizers. The seed of pulses are inoculated with *Phosphorus solublizers* with an objective of increasing their number in the rhizosphere and substantial increase in the P availability for the plant growth.

Phosphorus solubilizing microorganisms (bacteria and fungi) enable P to become available for plant uptake after solubilization. Several soil bacteria, particularly those belonging to the genera *Bacillus* and *Pseudomonas*, and fungi belonging to the genera *Aspergillus* and *Penicillium* possess the ability to bring insoluble phosphates in soil into soluble forms by secreting organic acids such as formic, acetic, propionic, lactic, glycolic, fumaric, and succinic acids.

These acids lower the pH and bring about the dissolution of bound forms of phosphates. Some of the hydroxyl acids may chelate with calcium and iron resulting in effective solubilisation and utilization of phosphates. The phosphate solubilizing microorganisms improved phosphorus uptake over control with and without chemical fertilizers. There is lack of information on the use of PSM for mungbean under semi-arid region of Rajasthan. Thus, looking towards increasing need of use of biofertilizers with phosphatic fertilizers for maintenance of soil fertility at

sustainable level of production, the present have been undertaken.

## **Materials and Methods**

A field experiment was conducted during *kharif* season of 2015 at the Agronomy farm, S.K.N. College of Agriculture, Jobner (Rajasthan) in randomized block design with four replications.

The soil was loamy sand in texture, alkaline in reaction (pH 8.2), low in organic carbon ( $1.9 \text{ g kg}^{-1}$ ), available nitrogen ( $130.10 \text{ kg ha}^{-1}$ ), available phosphorus ( $15.87 \text{ kg ha}^{-1}$ ) and medium in available potassium ( $140.02 \text{ kg ha}^{-1}$ ) content.

The experiment consisted of four levels of phosphorus (Control, 20, 40 and  $60 \text{ kg P}_2\text{O}_5 \text{ ha}^{-1}$ ) and four treatments of biofertilizers (Control, PSB, *Aspergillus awamori* and PSB + *Aspergillus awamori*) thereby, making sixteen treatment combinations. The mungbean var. RMG-492 sown on 18<sup>th</sup> July, 2015 using seed rate  $20 \text{ kg/ha}$  with a row spacing of 30 cm. The crop was harvested on 8th October, 2015.

As per treatments, seed was inoculated with PSB, *Aspergillus awamori* and PSB + *Aspergillus awamori* before sowing using standard method and dried shade (Paul *et al.*, 1971). Thinning was carried out at 10-20 DAS. A uniform basal dose of  $25 \text{ kg N ha}^{-1}$  was applied through DAP and urea to the soil. Urea was used to make up the quantity of N to  $25 \text{ kg ha}^{-1}$  in addition to N supplied through DAP. However, in control plots whole N was applied only through urea.

The phosphorus was applied through DAP as per the treatment details. Soil fertility and enzyme activities were analysed as per standard analytical procedures.

**Table.1** Soil fertility and enzyme activity influenced by phosphorus and biofertilizers

Treatments	Organic carbon (g kg <sup>-1</sup> )	Available nitrogen (kg ha <sup>-1</sup> )	Available phosphorus (kg ha <sup>-1</sup> )	Available potassium (kg ha <sup>-1</sup> )	Dehydrogenase enzyme activity (µg TPF g <sup>-1</sup> soil 24 h <sup>-1</sup> )	Alkaline phosphatase enzyme activity (µg PNP produced g <sup>-1</sup> soil h <sup>-1</sup> )
<b>Phosphorus levels</b>						
P <sub>0</sub> (Control)	1.990	130.89	15.98	139.18	9.05	9.43
P <sub>1</sub> (20 kg P <sub>2</sub> O <sub>5</sub> ha <sup>-1</sup> )	2.150	138.56	17.99	149.30	10.79	11.03
P <sub>2</sub> (40 kg P <sub>2</sub> O <sub>5</sub> ha <sup>-1</sup> )	2.290	145.56	19.88	158.22	12.09	11.82
P <sub>3</sub> (60 kg P <sub>2</sub> O <sub>5</sub> ha <sup>-1</sup> )	2.340	149.93	21.58	160.15	12.55	12.10
SEm <sub>±</sub>	0.044	2.34	0.55	2.87	0.30	0.25
CD (P = 0.05)	0.126	6.76	1.58	8.28	0.87	0.72
<b>Biofertilizers</b>						
B <sub>0</sub> (Control)	1.960	130.66	15.57	141.51	10.06	10.03
B <sub>1</sub> (PSB)	2.150	140.70	17.94	150.61	11.02	11.10
B <sub>2</sub> ( <i>Aspergillus awamori</i> )	2.250	143.28	19.96	153.13	11.17	11.17
B <sub>3</sub> (PSB + <i>Aspergillus awamori</i> )	2.410	150.30	21.96	161.61	12.22	12.09
SEm <sub>±</sub>	0.044	2.34	0.55	2.87	0.30	0.25
CD (P = 0.05)	0.126	6.76	1.58	8.28	0.87	0.72

## Results and Discussion

### Effect of phosphorus

Application of phosphorus to the soil, which was otherwise poor in its content favourably, influenced the photosynthesis, biosynthesis of proteins and phospholipids and other metabolic processes of the plant resulting into better root development and proliferation. Application of P increased total biomass (grain and straw) in mungbean by providing balanced nutritional environment inside the plant and higher photosynthetic efficiency.

Phosphorus application favourably responded to buildup N, P and K status of the soil after harvest of greengram (Table 1). Increasing trend for buildup of N, P and K status was noted with increase in level of phosphorus. Phosphorus application increased root nodulation which might have promoted microbial activity and thereby higher mineralization. Further, the release of organic acids and hormones due to phosphorus bacterial activity might have helped in availability of nutrients (Bhatt *et al.*, 2013).

The increase in dose of inorganic fertilizers increased the activity of dehydrogenase and alkaline phosphatase as recorded in treatment 40 kg P<sub>2</sub>O<sub>5</sub> ha<sup>-1</sup> (Table 1). It might be attributed to the fact that inorganic sources of nutrient stimulated the activity of microorganisms to utilize the native pool of organic carbon as a source of carbon. Similar findings were also reported by Khan *et al.*, (2015), Singh *et al.*, (2013), Choudhary (2013).

### Effect of biofertilizers

Solubilization of phosphorus by biofertilizers is attributed to extraction of acids like glutamic, succinic, lactic, oxalic, glyoxalic, malic, fumaric,  $\alpha$  -ketobutric, propionic and

formic. Some of these acids (hydroxyl-acid) may form chelates with cations such as Ca<sup>++</sup> and Fe<sup>++</sup> which resulted in effective solubilization of phosphates. In addition to phosphate solubilisation, these microbes can mineralize organic phosphorus and render more P into soil solution than required for their own growth and metabolism, the surplus is for plant to absorb. This might be the fact that PSB + *Aspergillus awamori* inoculation increase availability of N, P and K in soil (Table 1). The similar observation was recorded by Malik *et al.*, 2013.

Further, the root system of legumes has capacity to solubilize soil phosphorus through excretion of amino acids and encourage the growth and multiplication of soil microbes which finally led to mineralization of unavailable P to available P in soil (Singh *et al.*, 2013). Tarafadar *et al.*, (1988) reported that *Aspergilli* have highest phosphatase activity among the tested fungi in arid soils. The findings were found similar to Tagore *et al.*, (2013), Mondal *et al.*, (2015), Tripura (2015).

Based on the results of the experiment, it could be concluded that the application of phosphorus @ 40 kg ha<sup>-1</sup> and dual inoculation of biofertilizers (PSB + *Aspergillus awamori*) had significant effect on increasing soil fertility and enzyme activity in soil after harvest over the rest of the treatments.

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