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Effect of Integrate Use of Phosphorus, PSB and Vermicompost on Acid and Alkaline Phosphatase Activity and Yield of Green Gram (*Vigna radiata* L.)

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A B S T R A C T

Field experiment was conducted during *kharif*, 2016 on sandy loam soil to study the effect of phosphorus levels, biofertilizers (PSB) and organic manures (vermicompost) on acid and alkaline phosphatase enzyme activity and yield of green gram. The experiment was laid out in randomized block design with three replications having 12 treatment combinations *viz.* 3 levels of phosphorus (0, 75 and 100 % RDP) and its integration with PSB (2 kg ha^{-1}) and vermicompost (5 t ha^{-1}). Application of inorganic P alone decreased phosphotase enzyme activity from 0 to 100 % RDP level. Application of 100% RDP ha^{-1} resulted in a significantly lower acid and alkaline phosphatase activity both at flowering and at harvest of green gram. Application of vermicompost along with PSB seed inoculation (T_4) recorded significantly highest and activity of acid and alkaline phosphatase was151.33 and 277.33 µg p-nitrophenol g^{-1} soil h^{-1} and the lowest activity of 88.00 and 232.00 µg p-nitrophenol g^{-1} soil h^{-1} of acid and alkaline phosphatase activity respectively were registered under 100 % RDP treatment (T_9) in rhizosphere soil at flowering. Combined application of 100 % RDP along with PSB and vermicompost registered significantly highest grain and haulm yield in green gram.

Introduction

India is the largest producer of pulses in the world. In India, green gram represents 18% (34.4 lakh hectares) of total pulse area and 11.48 % (514 lakh tonnes) of pulse production (CMIE, 2014-15). Green gram is the third important pulse crop cultivated through India for its multipurpose use as vegetable, pulse, fodder and green manure crop, as it occupies good position due to its high seed protein content and ability to store the soil fertility through symbiotic nitrogen fixation. Despite occupying a greater position both in respect of area and production, the productivity of green gram is low compared to world average. One reason for this could be the imbalanced nutrient management. Farmers are not applying fertilizers and also cultivating green gram in marginal low fertile soils under rainfed conditions.

Phosphorus plays pivotal structural and regulatory role at the nexus of photosynthesis, root development, energy conservation and transformation, carbon metabolism, enzyme activation and nucleic acid synthesis (Vance *et al.*, 2003). The very high phosphatic fertilizer prices also demand the need for recycling and exploitation of fixed phosphorus to improve crop production. The availability of phosphorus to the crop can be augmented by providing appropriate strains of microbes which are known to solubilise the fixed phosphorus and mobilize the deeply placed phosphorus to root zone by their activity. Besides increasing the availability of native P in the soil also help in enhancing the use efficiency of applied phosphorus (Thenua and Sharma, 2011). Organic matter additions were found to mobilize the fixed phosphates in the soil thus increasing the available P to crops (Venkateswarlu, 2000). Keeping all these points in view a field experiment was conducted to study the effect of phosphorus, PSB, vermicompost on growth and yield of green gram.

Materials and Methods

A field experiment was conducted during *Kharif*, 2016 at College Farm, Agricultural College, Professor Jayashankar Telangana State Agricultural University, Polasa, Jagtial, Telangana State. The soil of the experimental field was sandy loam in texture and slightly alkaline in reaction (pH 7.84) having an organic carbon content of 0.364%, 157.5 kg available nitrogen ha^{-1}, 18.6 kg available P_2O_5 ha^{-1}, 164.8 kg available K_2O ha^{-1}, and 19.4 kg available sulphur ha^{-1}.

The experiment was laid out in randomized block design with three levels of phosphorus (0, 75 and 100 % RDP) and its integration with biofertilizers (PSB) and organic manures (vermicompost), all together 12 treatments replicated thrice. The various treatments were control (T_1- without any P application), seed inoculation of PSB (T_2), application of vermicompost @ 5 t ha^{-1} (T_3), PSB + vermicompost (T_4), 75 % RDP (T_5), 75 % RDPP + PSB (T_6), 75 % RDP + vermicompost (T_7), 75 % RDP + PSB + vermicompost (T_8), 100 % RDP (T_9), 100 % RDP + PSB (T_{10}), 100% RDP + vermicompost (T_{11}) and 100% RDP + PSB + vermicompost (T_{12}). The plots are uniformly basal dressed with 20 kg urea and 20 kg K_2O ha^{-1} and phosphorus applied as per the treatments. PSB and vermicompost applied as per the treatments. Rhizobium seed treatment was given to all the treatments. The green gram variety used LGG 460 sown with a spacing of 30 cm X 10 cm. The soil samples from individual treatmental plot were collected at flowering and after harvest and assayed for acid and alkaline phosphatase activities in the rhizosphere soil as described by Tabatabai and Bermner (1969) and Eivazi and Tabatabai (1977).

Results and Discussion

Acid phosphatase activity

Acid phopsphatase activity in the rhizosphere soil significantly decreased with increasing the level of phosphorus application. Lowest phosphatase activity of 88.00 and 42.33 µg p-nitrophenol g^{-1} soil h^{-1} was recorded in 100 % RDP treatment (T_9) in rhizosphere soil at flowering and harvest, respectively which was significantly lower than the activity of 89.67 and 45.33 µg p-nitrophenol g^{-1} soil h^{-1} in the control at flowering and harvest, respectively.

Significantly higher acid phosphatase activity of 151.33 and 66.33 µg p-nitrophenol g^{-1} soil h^{-1} was recorded with combined application of PSB and vermicompost (T_4) at flowering and harvest, respectively. It was evident from earlier research that under conditions of P deficiency the acid phophatase secreted from roots was increased and the plant roots applied with organic P or without P was significantly enhanced compared with those grown in inorganic P (Nakas *et al.*, 1987; Li *et al.*, 1997; Hays *et al.*, 1999) (Table 1).

Table.1 Haulm and seed yield (kg ha^{-1}), acid and alkaline phosphatase activity (µg g^{-1} soil h^{-1}) of green gram as influenced by graded levels of P in integration with vermicompost and PSB

Treatments	Yield (kg ha^{-1})		Acid phosphatase activity (µg g^{-1} soil h^{-1})		Alkaline phosphatase activity (µg g^{-1} soil h^{-1})	
	Haulm	Grain	At flowering	At harvest	At flowering	At harvest
T_1	993.33	703.33	89.67	45.33	242.67	119.33
T_2	1037.33	724.33	143.67	65.00	271.67	144.00
T_3	1066.66	749.67	139.67	63.33	271.33	142.33
T_4	1157.33	771.33	151.33	66.33	277.33	157.33
T_5	1259.33	831.00	88.33	42.67	238.00	119.17
T_6	1275.00	853.00	108.87	55.67	268.33	139.33
T_7	1379.66	868.67	104.00	52.17	265.33	135.00
T_8	1411.66	928.67	131.67	61.67	271.60	141.33
T_9	1456.66	956.67	88.00	42.33	232.00	118.60
T_{10}	1518.33	985.00	92.67	50.67	252.00	128.00
T_{11}	1566.00	996.00	91.67	46.00	249.00	123.00
T_{12}	1625.66	1033.33	93.33	51.00	257.33	129.33
CD	87.87	56.36	10.77	10.66	12.83	11.47
SE(D)	42.37	27.17	5.19	5.14	6.18	5.53

Alkaline phosphatase activity

Alkaline phosphatase activity in the rhizosphere was higher as compared to acid phosphatase activity. Application of vermicompost along with PSB inoculation (T_4) recorded significantly highest alkaline phosphatase activity of 277.33 and 157.28 µg p-nitrophenol g^{-1} soil h^{-1} at flowering and harvest, respectively. Lowest phosphatase activity of 232.00 and 118.60 µg p-nitrophenol g^{-1} soil h^{-1} was recorded in 100 % RDP treatment (T_9) in rhizosphere soil at flowering and harvest, respectively.

At flowering stage 100% RDP ha^{-1} + PSB, 100% RDP ha^{-1} + vermicompost and 100% RDP
ha^{-1} + PSB + vermicompost application significantly increased the alkaline phophatase activity over alone application of 100% RDP ha^{-1}. This could be due to the reason that the activity of PSB was greater at lower levels of P than higher levels and microbial population increased due to inoculation with PSB (Sarawgi *et al.*, 1999).

Yield of green gram

The grain yield and haulm yield significantly influenced by different phosphorus management practices. The seed yield was the highest when vermicompost and PSB were combinedly applied with inorganic P at 100 % RDP (T_{12}), the yield being 1033.33 kg ha^{-1} and it was found to be on par with T_{11} (996 kg ha^{-1}) and T_{10} (985.00 kg ha^{-1}) treatments. Integrated application of inorganic P along with vermicompost and PSB significantly increased the seed yield by 46.92% (T_{12} on T_1), 11.75% (T_8 on T_5) and 8 % (T_{12} on T_9) at P_0. P_{75} and P_{100} levels, respectively over inorganic P application at their respective level. Application of 75 % RDP alone (T_5) significantly increased the seed yield to 831.00 kg ha^{-1} over 703.33 kg ha^{-1} in control (T_1). The increased seed yield with P application might be due to increased P availability and uptake resulted profuse nodulation leading to greater symbiotic nitrogen fixation which in turn has positive effect on photosynthesis, then on yield (Rani *et al.*, 2016 and Kumar *et al.*, 2014).

Haulm yield was increased from a value of 993.33 kg ha^{-1} in the control (T_1) to 1625.66 kg ha^{-1} in the treatment (T_{12}) which was receiving 100 % RDP along with vermicomost and PSB and it was on par with T_{11} treatments. However, addition of 75 % RDP alone (T_5) significantly increased the haulm yield to 1259.33 kg ha^{-1} over control (T_1). Rathour *et al.*, (2014) reported that phosphorus involves in cell division, increases various metabolic processes and cell enlargement, application of phosphate solubilising bacteria releases growth promoting substances which improves the haulm yield.

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