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Review Article

Effect of Phosphorus Sources and Phosphorus Solubilizing Microorganism on Growth and Yield of Mungbean [Vigna Radiata (l.) wilczek]

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Abstract

A field experiment was conducted to study the effect of P-sources and P-solubilizers on plant growth and yield mungbean [*Vigna radiata* (L.) Wilczek]. Sixteen treatment combinations comprising of four P sources (control, SSP, phosphocompost and SSP + phosphocompost) and four P solublizing microorganisms (control, *Aspergillus awamori*, *Psuedomonas striata* and *A. awamori* + *P. striata*) were laid out in a randomized block design. SSP + phosphocompost recorded significantly higher plant height, dry matter accumulation per plant, number of branches per plant, total chlorophyll content, leaf area index, total and effective number of nodules per plant, number of pods per plant, number of seeds per pod, test weight, seed and straw yield as compared to control, SSP and phosphocompost alone. Similarly, a consortium of P solubilizers viz., *Aspergillus awamori* + *Psuedomonas striata* recorded significantly higher plant height, dry matter accumulation per plant, number of branches per plant, total chlorophyll content, leaf area index, total and effective number of nodules per plant, number of pods per plant, number of seeds per pod, test weight, seed and straw yield as compared to control, *Aspergillus awamori* and *Psuedomonas striata* alone. The experiment shows the importance of integrated approach in P fertilization in mungbean.

Keywords: *Aspergillus awamori*, Mungbean, growth, *Psuedomonas striata*, Seed yield

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Introduction

Pulses occupy a unique position in rainfed agriculture by their ability to conserve soil, tolerate moisture stress and to fix atmospheric nitrogen, there is always a great scope in enhancing its production and productivity by application of improved matching technologies. Mungbean is an excellent source of protein (25%) with higher content of lysine (460 mg/ g) and tryptophan (60 mg /g). It has also a remarkable quantity of ascorbiAc acid, riboflavin (0.21 mg/100 g) and minerals (3.84 g/ 100 g) when sprouted following soaking in water. Phosphorus is an important essential nutrient next to nitrogen. It is an indispensable constituent of nucleic acid, ADP and ATP. It has beneficial effects on nodule stimulation, root development and crop growth and also hastens maturity as well as improves quality of crop produce. phosphate, phosphogypsum, phosphocompost (PROM) are used. Now a days PROM proves to be a better source for P application. Being a water insoluble source of P, its availability in neutral to alkaline soil is very poor. Certain phosphate dissolving microorganisms (PDM) could also be used as a means to improve the efficacy of rock phosphate and superphosphate [1]. The present investigation was carried out to evaluate the performance of *Pseudomonas striata* Chester and *Aspergillus awamori* as single or composite inoculants with and without rock phosphate and superphosphate on a rainfed mungbean crop in entisoils.

Material and Methods

A field experiment was conducted during *Kharif* 2012 Jobner, Jaipur. The experiment field soil was loamy sand, belonging to hyperthermic family of Typic Ustipsamments with mustard crop in *Rabi*. Four phosphorus sources included SSP, PROM, SSP+PROM and a control; while four P solublizers included *Aspergillus awamori*, *Psuedomonas striata, A.awamori+ Psuedomonas* and a control. These treatments were triad in a randomized block design and replicated thrice. Sowing of mungbean 'RMG-268' was made at 30 cm row spacing with seed rate of 15 kg/ha. P-solublizers were applied in combination with fertilizers to the plots along with the other fertilizer as per layout plant. Observation on plant height, dry matter accumulation per plant, number of branches per plant, total chlorophyll content, leaf area index, total and effective number of nodules per plant, number of pods per plant, number of seeds per pod were recorded during at crop growth period and test weight, yield of seed (kg/ha) and stalk (kg/ ha) were recorded at harvest.

Result and Discussion

Effect of sources of phosphorus

Growth characters

Application of SSP + PROM proved most effective in increasing, plant height, dry matter accumulation, number of branches per plant, total chlorophyll content, leaf area index, total and effective root nodules as compared to control, SSP and PROM (**Table 1**). Phosphorus serve as a source of energy for microorganism and enhanced their performance in various beneficial functions in soil. It is also associated with several vital functions and is responsible for many characteristics of plant growth. PROM is an organic source of nutrition and contains organic matter and various essential nutrients with phosphorus. Single Super Phosphate contains Phosphorus, Calcium and Sulphur which are primary and secondary plant nutrients for growth and development of the plant. PROM and SSP enhance the population and activity of Rhizobium bacteria in roots of mungbean and increase the number of effective and total root nodules when used as combination and it enhanced the availability of phosphorus in soil for the plant growth. These results are in conformity with the findings of [2-6].

Table 1 Effect of P- Sources and P- solubilizer on Yield attributed and yield in Mungbean

	Pods /plant	**Number of seeds /pod**	**Test weight (g)**	**Seed Yield (q/ha)**	**Straw Yield (q/ha)**
P- sources					
Control	21.86	7.84	30.74	4.4	8.22
SSP	28.85	10.48	30.85	6.79	11.78
PROM	29.47	10.92	31.02	7.24	12.45
SSP + PROM	31.95	11.8	33.58	8.38	13.84
SEm(+)	0.78	0.29	0.88	0.19	0.33
CD (0.05)	2.26	0.83	NS	0.55	0.94
P-solubilizers					
Control	21.94	7.92	30.76	4.59	8.2
Aspergillus awamori	29.04	10.55	30.91	6.42	11.89
Pseudomonas striata	29.36	10.8	30.98	6.9	12.52
A. awamori + P. striata	31.79	11.77	33.54	8.9	13.68
SEm(+)	0.78	0.29	0.88	0.19	0.33
CD (0.05)	2.26	0.83	NS	0.55	0.94

Yield attributes and yield

Phosphorus application, SSP + PROM proved most effective in increasing, number of pods per plant, test weight, seed and straw yield as compared to control SSP and PROM (**Table 2**) Increase in yield and attributes are due to PROM, an organic source of nutrition and organic matter and various essential nutrients with phosphorus which provided food for beneficial microorganism in field and SSP an sources of phosphorus with Ca and sulphur.

The application of PROM along with SSP fertilizer increased the grain yield due to the increased availability of P through PROM, as besides acting as a source of nutrient , it also help in complexing Fe and Al in soil, thereby reducing the P fixing capacity [7]. The combined application of SSP and PROM might have resulted in increased availability of nutrients due to the increase in microfauna which bring about transformation of nutrients. The beneficial effect of PROM addition is also related to the improvement in soil physical properties and soil health. The ample availability of nutrients due to application of SSP + PROM might have increased these yield attributes because nutrient supply favourably influenced the chlorophyll synthesis and hence increased carbohydrate metabolism. The favourable effect led to increased translocation of photosynthates towards seed, resulting in formation of bold grains. These results are in conformity with the findings of [4-6].

Table 2 Effect of P- Sources and P- solubilizer on Plant height, Dry matter accumulation, Total chlorophyll content at flowering, Leaf area index at flowering and Nodule per plant at flowering in Mungbean

	Plant Height (cm)			Dry matter accumulation (gm per palnt)			Branches per plant	Total cholorophyll content (mg/g)	Leaf area index	Nodule per plant at flowering	
	30 DAS	60 DAS	At harvest	30 DAS	60 DAS	At harvest				Total nodules	Effective nodules
P- sources	11.57	33.17	39.14	3.8	72.05	96.1	9.44	3.09	1.49	35.74	23.24
Control	13.18	36.2	42.59	4.51	78.49	104.56	10.38	3.41	1.66	40.65	29.12
SSP	14.09	36.32	42.73	4.82	79.73	104.63	10.94	3.71	1.74	41.36	29.96
PROM	15.58	39.36	46.43	5.38	86.54	113.76	12.2	4.2	2.04	44.35	32.84
SSP + PROM	0.38	0.83	1.19	0.13	2.21	2.92	0.3	0.1	0.05	0.93	0.86
SEm(+)	1.1	2.4	3.43	0.37	6.37	8.42	0.87	0.29	0.14	2.67	2.5
CD (0.05)	11.57	33.17	39.14	3.8	72.05	96.1	9.44	3.09	1.49	35.74	23.24
P-solubilizers	11.47	33.05	39.15	4.07	72.45	96.05	9.51	3.12	1.46	35.78	24.95
Control	13.42	36.07	42.64	4.48	78.94	104.65	10.42	3.46	1.72	40.94	28.4
Aspergillus awamori	14.2	36.75	42.78	4.62	79.36	104.92	10.88	3.65	1.77	41.18	29.36
Pseudomonas striata	15.33	39.18	46.32	5.34	86.06	113.43	12.15	4.18	1.98	44.2	32.45
A. awamori + P. striata	0.38	0.83	1.19	0.13	2.21	2.92	0.3	0.1	0.05	0.93	0.86
SEm(+)	1.1	2.4	3.43	0.37	6.37	8.42	0.87	0.29	0.14	2.67	2.5
CD (0.05)	11.47	33.05	39.15	4.07	72.45	96.05	9.51	3.12	1.46	35.78	24.95

Effect of phosphorus solubilizing microorganism

Growth Characters

Seed Inoculation with Aspergillus awamori + Pseudomonas striata significantly increased the plant height, dry matter accumulation, number of branches per plant, total chlorophyll content, Leaf area index, total and effective root nodules per plant over no inoculation (Table 1) Aspergillus awamori and Psuedomonas striata and both Aspergillus awamori and Psuedomonas striata inoculation were at par with each other. Also phosphorus is associated with several vital functions and is responsible for many characteristics of plant growth. Solubilization of phosphorus by phosphate solubilizing microoranisms is attributed to extraction acids like glutamic, succinic, lactic, oxalic glyoxalic, maleic, fumaric, a –ketobutric, propionic and formic. Some of these acids (hydroxyl-acid) may form chelates with cations such as Ca++ and Fe++ which resulted in effective solubilization of phosphates in addition to phosphate solubilization of these microbes can mineralizes organic phosphorus and because of the microoranisms render more P into soil solution than required for their own growth and metabolism, the surplus is for plant to absorb.The inoculation with Aspergillus awamori + Pseudomonas striata also significantly increased the values of growth parameters as its combination gave synergistic effect. A positive influence of Aspergillus awamori inoculation on plant growth parameter was observed due to higher enzyme activities in the rhizosphere and better nutrient availability besides the production of the plant growth regulators by PSM which stimulate plant growth. The production of organic acids such as lactic, glycolic,and succinic acids in the medium of A awamori. can solubilize unavailable inorganic phosphates. The plant growth regulators such as ethylene and auxin, gibberellin, and cytokinin-like substances were produced by non-mycorrhizal fungi associated with the roots of forest tree. Psuedomonas striata also produce fungistatic and growth promoting substances which influences plant growth. The beneficial effects of phosphorus solubilizing micro-oranisms in India was also found by [1] on arhar, gram, soybean, lentil, pea, urd and other crops. The results obtained in the investigation are in line with the findings of [8, 9].

Yield attributes and yield

It was observed that the combined seed inoculation of Aspergillus awamori + Pseudomonas striata significantly increased pods per plant, seeds per pod, test weight, seed and straw yield over no inoculation, Aspergillus awamori and Psuedomonas striata and both Aspergillus awamori and Psuedomonas striata dual inoculation were at par with each other (Table 2). As already discussed in preceding paragraphs, phosphorus plays a unique role in energy conservation and transfer. Phosphorus solubilizing microorganisms (bacteria and fungi) enable P to become available for plant uptake after solubilization secreting organic acids such as formic, acetic, propionic, lactic, glycolic, fumaric, and succinic acids. 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. Seed inoculation with Aspergillus awamori increased the better root development and more nutrient availability, resulting in vigorous plant growth which resulted in better flowering, fruting and pod formation and ultimately there was beneficial effect on seed yield. The increase in seed and straw yield was due to the cumulative effect of increased growth and yield attributes. The finding of this investigation is in line [10, 11]

Conclusion

On the basis of one year field experimentation, it can be concluded that under agro-climatic conditions of zone IIIA (semi-arid eastern plain), application of phosphorus through SSP + PROM and seed inoculation with Aspergillus awamori + Psuedomonas striata is a remunerative approach in maximizing the crop productivity. However, these results are only indicative and require further field experimentation for confirmation and generating recommendation for the farming community

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