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Phosphate solubilising inoculants on (Jumpstart) growth parameters of rice (*Oryza sativa* L.)

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Abstract

Phosphorus (P) plays an important role in several physiological and biochemical activities in plants. P in soils is incapacitated due to formation of impenetrable complexes such as iron and aluminium hydrous oxides and calcium carbonate. Phosphate-solubilizing microorganisms (PSM) play a contributor in insoluble phosphates into soluble forms involves processes of acidulation, ion chelation and exchange reactions. In this experiment was carried out to study the Growth parameters of phosphate solubilising inoculants (JumpStart) on rice variety CO 47 in rice crop. The present study revealed that the treatment P₃S₃ (100% P + JumpStart 10E5) was recorded increased Seedling Growth will be increase in P₃S₃ treatment. The Plant Height will be increased at grain filling (111.67 cm), Root/ Shoot ratio (0.494 mg g⁻¹) and Root Volume will be increased at Active tillering and 50% flowering stage. The uptake of P by plants was found higher in P₃S₃ treatment observed at all stages of crop growth. At 50% flowering stage, phosphorus (69.26 kg ha⁻¹), uptake were observed higher in P₃S₃ treatment than control. This might be due to the significant increment of major Growth Parameters such as Root and Shoot ratio by the application of 100% recommended P with seed treatment of 10E5 JumpStart.

Keywords: Phosphours, PSM, jump start, azophos, growth parameters and rice

Introduction

Phosphorus is an important nutrient required by rice (Kim *et al.*, 1998) [13] and it has a defined role in part of the plants, Meiosis, Phospholipids and reproductive parts, metabolisms such as root development, photosynthesis, nutrient transport within the plant, (Rasipour and Asgharzadeh, 2007) [20]. The judicious and proper use of phosphorous in rice markedly increases the yield and quality of rice. Without adequate supply of plant with phosphorous, plant cannot attain its maximum yield. In the world low level of P is one of the major constraints for rice production. This is particularly apparent under upland conditions commonly characterized by erodible, poorly fertile, badly leached, highly acidic, and P-sorption soils, normally with minimum or no fertilizer applied (IRRI, 1997) [28]. P deficiency is identified as under lowland conditions it's a main factor for restraining the performance of modern rice varieties to approach their optimum yields. P deficiency quick remedy for rice field application of P fertilizers. However, inorganic fertilizers are not always available for rice farmers. Besides, some rice soils having low level of P can also fix it into a highly less soluble mineral. Dobermann *et al.*, (1998) [4] resulted that more than 90% of the P fertilizer are not easily available to plants. The microorganisms perform an important role in agriculture by supplying nutrients to plants and reduce the demand of chemical fertilizers (Cakmakci *et al.*, 2006) [2].

The use of P solubilizing microorganisms improves the soil fertility and increase the crop production to fulfil the requirement. Phosphorus solubilising fungus (*Penicillium bilaii*) is a newly isolated soil fungus that has serious effect on solubilisation of phosphorus. The success of *Penicillium bilaii* has been test verified in various crops such as chick pea, wheat, mustard canola, and lentil. Although, the advantage of *Penicillium bilaii* has not been tested in rice crop under machine transplanting system. The present study was conducted at field level to evaluate the performance of different inoculation of *Penicillium bilaii* in combination with three levels of P fertilizer on rice crop.

Materials and Methods

The experiment was carried out in the field, Department of Rice, TNAU, CBE at 2015. Rice (CO 47) variety seed material collected from Department of Rice. Before sowing, three bags (1 kg each) of rice seeds were soaked in 1 day. Seeds are treated with three Population of

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Phosphate solubilising inoculants on Jump Start at the rate of 160 Mg / Kg of seeds and add 6 ml of water after that wait for 1 minute as per the treatments and compared with the recommended seed treatment of bio fertilizer like Azophos at the rate of 20g/ kg of seeds and control (No seed treatment).

The experiment was formulated in split plot design with three (3) replications. The three Main plot treatments was follows and three (3) different P levels P₁- 0 (%) (0 kg P/ ha), P₂- 50 (%) P (25 kg P/ha) and P₃-100 (%) P, (50 kg P/ ha) (Recommended dose). Five Sub plot seed treatments as S₁- No Seed Treatment, S₂- 10E4 JumpStart (0.00967 mg/kg of seeds), S₃-10E5 JumpStart (0.0967 mg/kg of seeds), S₄- 10E6 JumpStart (9.667 mg/ kg of seeds) and S₅- Azophos at the 20 g/kg of seeds. For field observation and lab study five plants were selected at different growth stages of rice crop.

Results and Discussion

Seedling Growth Parameters

Seedling parameters i.e., root length, shoot length, root volume, number of roots, root shoot ratio, dry weight of seedling and vigour index acid were observed with different seed inoculations of *Penicillium bilaii* in our study (Table.1). All the parameters were increased with higher P levels and *Penicillium bilaii* (10E5 JumpStart). *Penicillium bilaii* released maximum amount of Pi and produced highest amount of IAA and GA results in increase in all parameters reported increased root length, shoot length and vigor index in maize when treated with bacterial strains. However, this study identifies the effects of *P. bilaii* on gross root morphology (i.e., root length and specific root length) under field conditions in rice crop. In contrary, specific root length of rice seedling was higher in P₃S₃, in line with the findings of that seed treatment with co-inoculation of *Azospirillum* and *Bradyrhizobium* increase the SRL of soybean.

The influence of seed inoculants on seedling growth parameters like Shoot length S₃ (18.4 cm), Root length S₃ (14.2 cm), Root Volume S₃ (20.0 cc), No of roots seedling S₃ (18.0), Root/ Shoot ratio S₃ (0.92), Total Dry Weight S₃ (0.37 mg), Specific Root Length (401.4), Vigour Index (7.40), are presented in (Table.1) and found to be influenced by different seed inoculants. Among the different seed inoculants, (*Penicillium bilaii*) recorded higher values followed by S₂, S₄, S₅ and S₁.

Plant height

Plant height is considered as an important trait related to growth and development of a plant. The crop length was significantly increased at different crop stages when the seed was inoculated with *Penicillium bilaii* (JumpStart), a phosphorus solubilizing fungus. 100% P fertilizer in combination with S₃ (10E5JumpStart) have recorded

increase in plant height of 20.95 % at grain filling stage compared to control. The increase in plant height might be due to the increase activity of meristematic cells when phosphorus application is increased. Increase in shoot and root length may also be attributed to the production of plant growth promoting substances like IAA, GA and cytokine like substances by solubilizing microorganism. Increased cell elongation and multiplication due to enhanced nutrient uptake by plants following inoculation of P solubilizing microorganisms might have caused the increase in plant height reported positive correlation with phosphorus and plant height. The co-inoculation of *Azospirillum* and PSB significantly increased the shoot height of foxtail millet over the control. In contrary, Mehrvarz (2008) [15] reported that there is no effect of chemical fertilizer and phosphorus soluble microorganism in plant height.

Root parameters

Root characteristics such as root/shoot ratio and root volume, of rice plant at different growth stage had revealed the effect of different P levels and seed inoculation. Mehrvarz *et al.* (2008) [15] reported that phosphorus solubilizing bacteria increase root morphological characters like root length, and root volume in aerobic rice plants. On the present study among the different treatments, P₃S₃ (100% P + JumpStart 10E5) recorded large influence on root characteristics, which may be due to interaction effect of *Penicillium bilaii* with phosphorus levels. In this study related to maximum root volume was reported in P₃S₃ over control treatment (Fig.1). These results are in line with the findings rice in chickpea. The neutral or negative response on root-hair frequency with increasing P concentration reported in spinach, rape, tomato and Arabidopsis. These result are supported with the findings. Anghinoni and Barber (1980) showed that P starvation, rather than its provision, increased root to shoot dry weight ratios in corn (*Zea mays L.*) found that root to shoot ratio decreased with increasing P fertilization levels in celery. Treatment P₁S₁ (0.706 %) recorded higher root shoot ratio at Active tillering stage (Table 3). Higher root-shoot ratio is often reported for P stressed plants as compared with P sufficient plants. In our study similar reported that under P deficiency condition root – shoot ratio 20- 30 % increase in rice crop. The root growth and development would be more susceptible to declines in soil moisture, nutrients and temperature because of the shallow distribution of the root system in rice reported that phosphorus solubilizing bacteria (*Bacillus megaterium*) increased root parameters like rooting performances, like root length, dry matter content of root in mint plant. Under low - Phosphorus condition lateral root width will be increase in maize crop.

Table 1: Effect of Phosphorus levels and Jump start on seedling growth characters of rice

Treatments	Shoot length (cm)	Root length (cm)	Root volume (cc)	No. of roots	Root shoot ratio	Specific root length (cm)	Dry weight per seedling(g)	Vigour index
S ₁	15.3	8.8	12	13.0	0.56	1.7	0.24	4.56
S ₂	17.2	13.3	18	17.0	0.81	2.6	0.33	6.60
S ₃	18.4	14.2	20	18.0	0.92	2.8	0.37	7.40
S ₄	17.1	12.8	17	16.0	0.78	2.4	0.29	5.80
S ₅	16.4	12.7	15	15.0	0.72	2.3	0.27	5.40
Mean	16.88	12.36	16.4	15.8	0.758	2.36	0.3	5.952
SEd	0.024	0.034	0.050	0.033	0.0038	0.0072	0.0021	0.001
CD (P= 0.05)	0.054	0.079	0.116	0.075	0.0088	0.0167	0.0049	0.002

S₁-No seed treatment, S₃-10E5 JumpStart (0.966 g/kg of seed), S₂ - 10E4 JumpStart (0.097 g/kg of seed), S₄ -10E6 JumpStart (9.662 g/kg of seed), S₅ - Azophos (20 g/kg of seed)

Table 2: Effect of Phosphorus levels and Jump start on plant height (cm / plant) at different stages of rice crop.

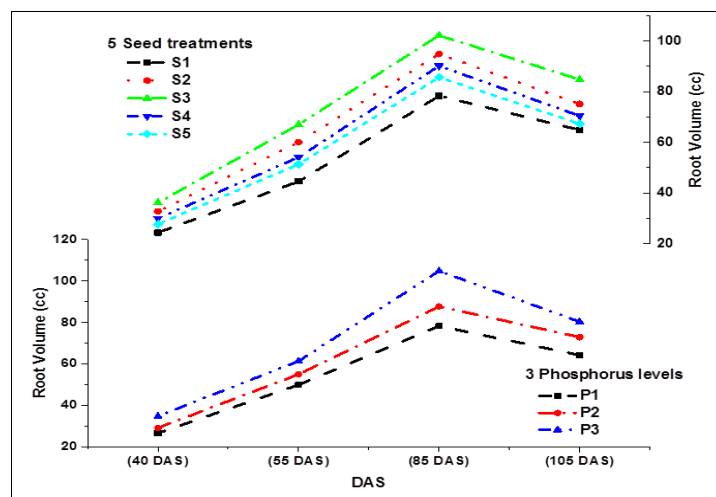
Treatments	Active Tillering (40 DAS)	Panicle Initiation (55 DAS)	Flowering (85 DAS)	Grain Filling (105 DAS)	Mean
P ₁ S ₁	42.63	62.12	85.67	92.33	70.69
P ₁ S ₂	46.30	68.60	90.33	100.00	76.31
P ₁ S ₃	48.59	70.72	96.33	104.67	80.08
P ₁ S ₄	45.83	65.55	87.33	96.67	73.85
P ₁ S ₅	44.55	63.55	86.00	94.67	72.19
P ₂ S ₁	45.90	63.00	87.67	96.00	73.14
P ₂ S ₂	49.90	68.53	92.00	103.33	78.44
P ₂ S ₃	52.53	71.10	99.50	107.33	82.62
P ₂ S ₄	47.10	66.27	90.00	97.67	75.26
P ₂ S ₅	46.14	64.97	89.00	95.00	73.78
P ₃ S ₁	47.06	66.13	92.00	98.33	75.88
P ₃ S ₂	51.00	70.93	98.00	106.00	81.48
P ₃ S ₃	53.55	74.47	103.33	111.67	85.76
P ₃ S ₄	49.35	68.37	97.00	100.33	78.76
P ₃ S ₅	48.64	66.55	96.33	99.67	77.80
Mean	47.94	67.39	92.70	100.24	
S at P SEd	0.969	1.415	1.094	1.601	
CD (P= 0.05)	1.999	2.920	2.257	3.304	

S₁-No seed treatment, S₃-10E5 JumpStart (0.966 g/kg of seed), S₂ - 10E4 JumpStart (0.097 g/kg of seed), S₄-10E6 JumpStart (9.662 g/kg of seed), S₅ - Azophos (20 g/kg of seed)

Table 3: Effect of Phosphorus levels and Jump start on Root – Shoot (R/S) ratio at different stages of rice

Treatments	Active Tillering (40 DAS)	Panicle Initiation (55 DAS)	Flowering (85 DAS)	Grain Filling (105 DAS)	Mean
P ₁ S ₁	0.706	0.658	0.487	0.434	0.571
P ₁ S ₂	0.577	0.583	0.447	0.415	0.506
P ₁ S ₃	0.562	0.563	0.438	0.393	0.489
P ₁ S ₄	0.591	0.602	0.467	0.400	0.515
P ₁ S ₅	0.668	0.591	0.477	0.422	0.540
P ₂ S ₁	0.650	0.638	0.476	0.421	0.546
P ₂ S ₂	0.576	0.559	0.421	0.400	0.489
P ₂ S ₃	0.531	0.533	0.415	0.381	0.465
P ₂ S ₄	0.605	0.572	0.438	0.415	0.508
P ₂ S ₅	0.638	0.547	0.458	0.428	0.518
P ₃ S ₁	0.618	0.524	0.459	0.395	0.499
P ₃ S ₂	0.528	0.507	0.411	0.371	0.454
P ₃ S ₃	0.494	0.489	0.367	0.359	0.427
P ₃ S ₄	0.551	0.546	0.425	0.404	0.482
P ₃ S ₅	0.583	0.513	0.436	0.403	0.484
Mean	0.592	0.562	0.441	0.403	
S at P SEd	0.0019	0.0017	0.0012	0.00059	
CD (P= 0.05)	0.0026	0.0023	0.0016	0.00121	

S₁-No seed treatment, S₃-10E5 JumpStart (0.966 g/kg of seed), S₂ - 10E4 JumpStart (0.097 g/kg of seed), S₄-10E6 JumpStart (9.662 g/kg of seed), S₅ - Azophos (20 g/kg of seed)



S₁-No seed treatment, S₃-10E5 JumpStart (0.966 g/kg of seed), S₂ - 10E4 JumpStart (0.097 g/kg of seed), S₄-10E6 JumpStart (9.662 g/kg of seed), S₅ - Azophos (20 g/kg of seed)

Fig 1: Effect of Phosphorus levels and Jump start on root volume (cc) at different stages of rice

Conclusion

I conclude that S₃- *Penicillium bilaii* (10E5 JumpStart) is the best one compare to other treatment from my research experiment in rice crop.

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