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Impact of Organics and P Solublilizing Micro Organisms on Phosphatic Fertilizers under Wetland Ecosystem

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Abstract: Field experiments were conducted at Tamil Nadu Agricultural University, Coimbatore during June - September and October - December 2006 to compare the efficiency of water soluble fertilizer i.e. Single super phosphate (SSP) and water insoluble fertilizer i.e. udaipur rock phosphate (URP) with or without FYM and P solubilizing microorganisms on phosphorus dissolution pattern and phosphatase activity. The results revealed that the dissolution of P was significantly higher with P fertilizer +FYM+P solubilising microorganisms, irrespective of the P sources. Higher phosphatase activity was observed in FYM treated plots. The net P balance was slightly positive in the treatment that received SSP +Azophos with or without FYM.

Key words: *Phosphorus, dissolution, P solubilising microorganisms, phosphatase activity, organic manure*

INTRODUCTION

Utilization of indigenously available phosphate rock is an imperative to the more expensive and imported water soluble P fertilizer. Treating phosphate rock with adjuncts such as FYM is found effective in steady release of P from phosphate rock and consequent increase in crop yields even in neutral and calcareous soils. The effects of organic manure on P dissolution in soil are expected to be markedly different under upland and waterlogged conditions[4]. In waterlogged soils, organic manuring increases the availability of P through the mechanism of reduction, chelation and favourable changes in soil pH. The P solubilising micro organisms is one of the avenues in increasing the availability of P from phosphate rock. Many fungi, bacteria and actinomycetes are potential solubilizers of bound phosphates in soil through secretion of organic acids[9]. The aim of the study was to evaluate the relative efficacy of P fertilizers, bio-organics viz., FYM, P solubilising micro organisms viz., phosphobacteria, VAM, azophos on P dissolution pattern, phosphatase activity and P balance in rice - rice cropping sequence under wetland ecosystem.

MATERIALS AND METHODS

Two field experiments were conducted in Madukkur soil series (Typic Haplustalf) at Tamil Nadu Agricultural University, Coimbatore during kharif (June-September) and rabi (October-January) seasons, using rice (var ADT 36) as test crop. The treatments consisted of two P sources viz., water soluble P fertilizer i.e. single super phosphate (SSP) and water insoluble P fertilizer i.e. udaipur rock phosphate (URP) @ 50 Kg P_2O_5 ha^{-1}, FYM @12.5 t ha^{-1}, P solubilising bacteria viz., phosphobacteria, azophos and P solubilising fungi VAM @ 2 Kg ha^{-1}. The initial soil characteristics are presented in Table 1.

Table 1: Physico-chemical properties of the initial soil

Properties	Unit	Value
Particle size distribution		
Clay	Per cent	21.92
Silt	Per cent	8.23
Fine sand	Per cent	42.78
Coarse sand	Per cent	23.36
Soil texture	Sandy clay loam	
Soil series	Madukkur	
Soil Taxonomy	Typic Haplustalf	
Physical properties		
Bulk density	Mg m^{-3}	1.43
Particle density	Mg m^{-3}	2.86
Pore space	Per cent	50.0
Electro-chemical properties		
pH	-	7.20
Electrical conductivity	dSm^{-1}	0.20
Cation Exchange Capacity	C mol(p+)Kg^{-1}	22.2
Chemical properties		
Available N (Alk-$KMnO_4$-N)	Kg ha^{-1}	145.0
Available P (Olsen-P)	Kg ha^{-1}	9.0
Available K ($NNNH_4OAc$-K)	Kg ha^{-1}	249.0
Phosphatase activity	EUx10^{-2}	0.20

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The P dissolution pattern was studied at tillering, panicle initiation and post harvest stages[8]. The phosphatase activity was measured after the harvest of the crop as suggested by Tabatabai and Bremner[10].

RESULTS AND DISCUSSIONS

Phosphorus Dissolution Pattern: The dissolution of P as determined by Olsen method was significantly higher with P fertilizer + FYM + P solubilising microorganisms, irrespective of the P sources than application of P fertilizer + P solubilising microorganisms with out FYM during all growth stages of the crop (Table 2). The decomposition of the organic manures could have modified soil conditions through the release of organic acids[7]. The increased solubility of the water insoluble phosphate rock in FYM added plots might have attributed to the action of the decomposition products. This probably involved the chelation of Ca from the phosphate rock resulting in increased P release[1]. The organic acids also could have increased the availability of P by decreasing adsorption and fixation[6].

Table 2: Effect of P sources, FYM and P solubilising microorganisms on available-P (Olsen-P) status (Kg ha^{-1}) – Kharif 2006

Treatments	Tillering		Panicle Initiation		Post-harvest	
T1-SSP+PB+FYM	21.5		17.0		14.0	
T2- SSP+PB-FYM	18.0		14.5		11.0	
T3- RP+PB+FYM	17.0		15.5		10.5	
T4- RP+PB-FYM	15.5		12.5		8.5	
T5 –SSP+AP+FYM	27.5		22.5		17.5	
T6- SSP+AP-FYM	24.0		19.0		15.5	
T7- RP+AP+FYM	23.6		20.0		13.5	
T8- RP+AP-FYM	19.5		16.0		11.5	
T9- SSP+VAM+FYM	25.0		20.5		15.0	
T10- SSP+VAM-FYM	21.5		18.0		13.0	
T11- RP+VAM+FYM	20.0		16.5		12.0	
T12 –RP+VAM-FYM	17.7		13.5		10.0	
	SED	CD	SED	CD	SED	CD
Bio- fertilizer	0.84	1.73	0.59	1.22	0.70	1.46
Phosphorus	0.68	1.41	0.48	0.99	0.57	1.19
Bio x P x Organics	1.67	3.46	1.18	2.43	1.40	2.91

Table 2 (a): Effect of P sources, FYM and P solubilising microorganisms on Available - P (Olsen-P) status (Kg ha^{-1}) – Rabi, 2006

Treatments	Tillering		Panicle Initiation		Post-harvest	
T1-SSP+PB+FYM	23.5		20.5		18.0	
T2- SSP+PB-FYM	20.0		17.0		14.5	
T3- RP+PB+FYM	21.5		18.5		13.0	
T4- RP+PB-FYM	18.0		15.0		11.5	
T5 –SSP+AP+FYM	27.0		25.5		20.0	
T6- SSP+AP-FYM	26.0		22.0		18.5	
T7- RP+AP+FYM	25.5		24.0		17.0	
T8- RP+AP-FYM	22.0		20.5		15.5	
T9- SSP+VAM+FYM	26.5		21.0		18.0	
T10- SSP+VAM-FYM	23.5		19.0		16.5	
T11- RP+VAM+FYM	22.0		20.0		15.0	
T12 –RP+VAM-FYM	20.0		17.0		13.5	
	SED	CD	SED	CD	SED	CD
Bio- fertilizer	0.72	1.46	0.77	1.61	0.69	1.50
Phosphorus	0.57	1.19	0.63	1.32	0.59	1.23
Bio x P x Organics	1.39	2.90	1.55	3.22	1.45	3.00

Table 3: Effect of P sources, FYM and P solubilising microorganisms on Phosphatase activity in post-harvest soils (EUx 10^{-2})

Treatments	Kharif		Rabi	
T1-SSP+PB+FYM	0.46		0.74	
T2- SSP+PB-FYM	0.32		0.58	
T3- RP+PB+FYM	0.41		0.66	
T4- RP+PB-FYM	0.24		0.42	
T5 –SSP+AP+FYM	0.84		1.24	
T6- SSP+AP-FYM	0.61		0.91	
T7- RP+AP+FYM	0.59		0.76	
T8- RP+AP-FYM	0.40		0.62	
T9- SSP+VAM+FYM	0.69		0.81	
T10- SSP+VAM-FYM	0.57		0.68	
T11- RP+VAM+FYM	0.52		0.60	
T12 –RP+VAM-FYM	0.37		0.44	
	SED	CD	SED	CD
Bio fertilizer	0.017	0.036	0.026	0.055
Phosphorus	0.014	0.030	0.022	0.045
BioxPxOrganics	0.035	0.073	0.053	0.109

Table 4: Net P balance as influenced P fertilizers +bio-inoculants

Treatments	Total P uptake		Partial Net P balance (Fertilizer P input-Total P uptake)	
	Kharif	Rabi	Kharif	Rabi
T1-SSP+PB+FYM	28.9	33.9	21.1	16.1
T2- SSP+PB-FYM	22.0	26.5	28.0	23.5
T3- RP+PB+FYM	26.4	26.3	23.6	23.7
T4- RP+PB-FYM	19.5	22.3	30.5	27.7
T5 –SSP+AP+FYM	40.5	45.5	9.5	4.5
T6- SSP+AP-FYM	34.1	41.8	15.9	8.2
T7- RP+AP+FYM	34.2	38.2	15.8	11.8
T8- RP+AP-FYM	27.6	31.0	22.4	19.0
T9- SSP+VAM+FYM	37.6	40.6	12.4	9.4
T10- SSP+VAM-FYM	30.9	28.6	19.1	21.4
T11- RP+VAM+FYM	31.0	36.0	19.0	14.0
T12 –RP+VAM-FYM	24.2	28.1	25.8	21.9

Table 5: Agronomic P efficiency (APE) and Physiological P efficiency (PPE)

Treatments	APE		PPE	
	Kharif	Rabi	Kharif	Rabi
T1-SSP+PB+FYM	69.7	79.2	226.3	217.5
T2- SSP+PB-FYM	58.0	67.8	241.6	242.2
T3- RP+PB+FYM	66.9	69.6	238.9	223.0
T4- RP+PB-FYM	56.4	55.6	258.5	217.3
T5 –SSP+AP+FYM	88.3	102.1	197.1	208.3
T6- SSP+AP-FYM	71.7	88.3	176.6	200.8
T7- RP+AP+FYM	79.9	91.5	202.8	222.2
T8- RP+AP-FYM	65.0	78.7	204.4	238.6
T9- SSP+VAM+FYM	85.0	93.9	205.3	221.6
T10- SSP+VAM-FYM	68.7	78.3	183.7	249.5
T11- RP+VAM+FYM	80.3	85.0	232.1	217.9
T12 –RP+VAM-FYM	62.5	72.1	212.7	226.7

Among the P solubilising micro organisms, the treatments that received azophos recorded the highest available P as compared with phosphobacteria and VAM. Dissolution of P by P solubilising micro organisms is mainly by the production of organic acids although chelating substances also have an important role. The type of organic acids produced and their amount differ with different micro organisms. Aliphatic acids are found to be more effective in phosphate solubilization than phenolic acids and citric and fumaric acids had highest P solubilising ability[3].

Table 6: Relationship between Olsen-P and other parameters

Regression equation	'r'
Kharif	
Olsen-P = 5.52+14.25 (Phosphatase activity)	0.93
Olsen-P = 0.87+1.26 (Grain P uptake)	0.90
Olsen-P = 0.33+0.99 (Straw P uptake)	0.90
Rabi	
Olsen-P = 8.76+10.14 (Phosphatase activity)	0.88
Olsen-P = 4.47+0.62 (Grain P uptake)	0.86
Olsen-P = 0.33+0.99 (Straw P uptake)	0.61

Phosphatase Activity: The phosphatase activity was higher after the harvest of rabi crop. The water soluble fertilizer, SSP increased the phosphatase activity. This could be due to the increased bioavailable P which enhance the growth of rhizosphere microorganisms (12). Higher phosphatase activity was observed in FYM treated plots (Table 3). Organic manuring might have stimulated the growth of soil microorganisms, thereby increasing the activity of phosphatase enzyme[11].

Net P Balance: In both the seasons, Olsen-P content depleted in FYM applied plots. The Olsen-P depletion was higher in SSP treated plots than in URP treated plots. This could be due to the residual effect of URP. In all plots, net P balance was positive. This could be due to the application of P @ 50 kg ha^{-1}. The P fertilizer rates of 17-25 kg ha^{-1} were high enough to maintain positive P balance (2). The net P balance was slightly positive in the treatment that received SSP+Azophos with or without FYM (Table.4)

Physiological P Efficiency (PPE) and Agronomic P Efficiency (APE): The treatment that received P fertilizer + Azophos registered high P supply. In the minus FYM treatments, depletion of Olsen-P was low (Table 4) with a limited supply of soil P, the crop utilizes the acquired P more efficiently in the formation of grain yield[5]. Physiological P efficiency was calculated from P uptake data and is presented as kg grain / kg P uptake (Table 5). The treatment that received P fertilizer + Azophos registered low PEE. A negative correlation between PEE and P uptake was observed.

Agronomic P efficiency was the highest in the treatment that received SSP+AP+FYM. This indicated that P was efficiently utilized in this treatment. Treatments that have not received FYM recorded low APE showing low P utilization.

Correlations: The correlation coefficient of available P at harvest stage was found significant with phosphatase activity and P uptake at harvest stage in both seasons (Table 6). Highly significant correlation between available P and phosphatase activity could be attributed to the increase in Olsen-P with increase in phosphatase activity. The correlation between Olsen-P and phosphatase activity, Olsen-P and grain P uptake decreased after rabi crop.

Conclusion: The results revealed that the dissolution of P was significantly higher with P fertilizer +FYM+P solubilising microorganisms, irrespective of the P sources. Higher phosphatase activity was observed in FYM treated plots. The net P balance was slightly positive in the treatment that received SSP + azophos with or without FYM.

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