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Effect of phosphates on yield and nutrient uptake in paddy

G. KISHORE BABU AND B. V. SESHAIAH

Department of Soil Science and Agricultural Chemistry, Agricultural College, Bapatla-522 101, India.

Abstract : A pot experiment was conducted to evaluate the effect of three levels of P (0, 30 and 60 kg P_2O_5 ha^{-1}) applied through single superphosphate (SSP) and rock phosphate (RP) and their mixture (1:1) and two types of organic manures viz., FYM and green manure (*Dhaincha*) applied at 5 t ha^{-1}, on yield and nutrient uptakes in paddy. The grain and straw yields increased with increase in P levels irrespective of the sources. Single super phosphate was found to be more effective than rock phosphate. Application of 30 kg P_2O_5 as SSP + 30 kg P_2O_5 as RP ha^{-1} was less effective than 60 kg P_2O_5 ha^{-1} applied through SSP. The effectiveness of P sources enhanced when they were applied with organic manures. Phosphorus application alone or in combination with organic manures resulted in a significant increase in uptake of the nutrients in grain and straw yields.

Additional key words : *Shrink-swell soils, farm yard manure, green manure.*

Introduction

Use of rock phosphate, as a source of P, is restricted in soil as it contains phosphorus in water insoluble form but its solubility gets increased with decrease in soil pH. Addition of organic manures like farm yard manure (FYM) and green manure (GM) hastens the conversion of water insoluble rock phosphate to available forms. However, the contribution of rock phosphate needs to be established in crops like rice. Keeping this in view, the present investigation was carried out to study the effect of rock phosphate as a source of phosphorus for rice in comparison with single super phosphate (SSP) on grain yield and nutrient uptake.

Material and Methods

Pot experiment with three replications under CRD design was conducted at Agricultural College Farm, Bapatla with soil (Typic Haplusterts) low in phosphorus collected from paddy growing area of Appikatla village in Guntur district. The bulk soil sample was air dried and was passed through 2 mm sieve. Each pot was filled with 8 kg of soil. Mussoorie rock phosphate had 20% of total P_2O_5. The treatments consisted of : T_1- Control, T_2 - FYM 5.0 t ha^{-1} , T_3- Green manure (GM) 5.0 t ha^{-1}, T_4 - 30 kg $P_2O_5ha^{-1}$ as SSP, T_5 - 30 kg $P_2O_5ha^{-1}$ as RP, T_6 - 60 kg $P_2O_5ha^{-1}$ as SSP, T_7 - 60 kg $P_2O_5ha^{-1}$ as RP, T_8 - 30 kg $P_2O_5ha^{-1}$ as RP + 30 kg P_2O_5 ha^{-1} as SSP, T_9 - 60 kg $P_2O_5ha^{-1}$ as SSP + 5.0 t FYM ha^{-1}, T_{10} - 60 kg P_2O_5 ha^{-1} as SSP + 5.0 t GM ha^{-1} , T_{11} - 60 kg $P_2O_5ha^{-1}$ as RP + 5.0 t FYM ha^{-1}, T_{12} - 60 kg $P_2O_5ha^{-1}$ as RP + 5.0 t GM ha^{-1} , T_{13} - 30 kg $P_2O_5ha^{-1}$ as SSP + 30 kg $P_2O_5ha^{-1}$ as RP + 5.0 t FYM ha^{-1} and T_{14} - 30 kg P_2O_5 ha^{-1} as SSP + 30 kg P_2O_5 ha^{-1} as RP + 5.0 t GM ha^{-1}.

A uniform dose of nitrogen @ 120 kg ha^{-1} was supplied through urea in three equal splits (at planting, maximum tillering and panicle initiation stages) and potassium @ 60 kg K_2O ha^{-1} through muriate of potash as basal. Phosphorus, FYM, GM (Dhaincha) were applied as per the treatments. A uniform basal dose of zinc sulphate @ 50 kg ha^{-1} was applied. Thirty five day old rice seedlings (var. NLR-28600) were transplanted two weeks after application of organic manures at the rate of three seedlings per hill and three hills per pot. The pots were irrigated to keep about 2 cm depth of water except at the time of top dressing. At maturity, the plants were harvested and grain and straw yields were recorded. Representative samples of straw and grain were collected and analysed for N, P, K, Zn, Cu, Fe and Mn following standard procedures (Jackson 1973).

Table 1. Properties of the experimental soil

Characteristic	Value	Reference
Sand (%)	33.6	Piper (1966)
Silt (%)	10.2	
Clay (%)	54.2	
pH	7.6	Jackson (1973)
Electrical conductivity (dS m^{-1})	0.36	
Cation exchange capacity (cmol (p+) kg^{-1})	46.5	
Organic carbon (%)	0.28	
Available N (kg ha^{-1})	283	Subbiah and Asija (1956)
Available P_2O_5 (kg ha^{-1})	16.5	Watanabe and Olsen (1965)
Available K_2O (kg ha^{-1})	323	Jackson (1973)
Available Zinc (mg ha^{-1})	1.23	Lindsay and Norvel (1978)
Available iron (mg ha^{-1})	6.38	
Available manganese (mg ha^{-1})	8.20	
Available copper (mg ha^{-1})	0.49	

Results and Discussion

Significant differences in straw and grain yield of paddy were noticed due to different levels and sources of P. The mean grain and straw yields (Fig. 1) for different treatments ranged from 5.94 and 8.53 in T_1 to 27.5 and 30.71 g pot^{-1} in T_9, respectively. The grain yield obtained in T_9 was the highest and it was comparable with that of T_{11} (26.50 g pot^{-1}) and T_{13} (26.06 g pot^{-1}). The grain yield in T_7 was statistically at par with T_4. This might be due to the fact that in RP treated soil, plants had little water soluble P to meet their demand, unlike in SSP treated soils. The situation is augmented by applying FYM, decomposition of which produced many organic acids which solubilized RP and enact release of water soluble P at a steady rate over a period. Similar results of superiority of SSP alone or in combination with over RP (with and without FYM) for increasing paddy grain and straw yields in neutral soils were also reported (Ravi *et al.* 2002; Misra *et al.* 2002). There was significant increase in concentration (Table 2) and uptake of nutrients with SSP than RP. However, the concentration and uptake of nutrients in grain and straw increased linearly with an increase in phosphorus levels irrespective of sources. Those parameters further increased when phosphatic fertilizers were applied in combination with organic manures. Farmyard manure was found to be superior than green manure in increasing the concentration and uptake of nutrients. The concentration and uptake were much higher in T_6 than T_8. The data indicated that variations in uptake (Table 3) of nutrients among different treatments might be due to differences in grain and straw yields. Increase in concentration and uptake of N, P, K, Fe, Mn, Zn and Cu in rice grain and straw due to phosphorus application were also reported by Nagendra Rao (1986) and Alam and Azmi (1989).

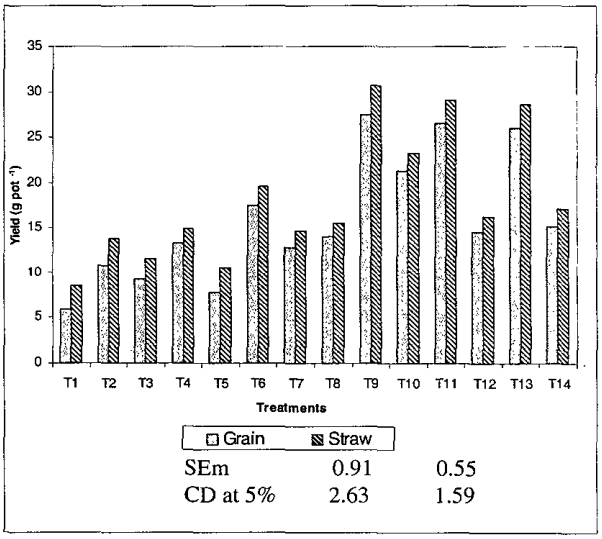

Fig. 1. Effect of sources and levels of phosphorus and organic manures on yield of paddy

Table 2 : Effect of phosphorus levels and organic manures on nutrient concentration in grain and straw

Treatments	N (%)		P (%)		K (%)		Zn (mg kg^{-1})		Fe (mg kg^{-1})		Mn (mg kg^{-1})		Cu (mg kg^{-1})	
	Grain	Straw	Grain	Straw	Grain	Straw	Grain	Straw	Grain	Straw	Grain	Straw	Grain	Straw
T_1	0.81	0.68	0.22	0.08	0.30	0.82	23.3	20.0	120	332	50	205	18.5	24.1
T_2	0.82	0.72	0.28	0.11	0.34	0.98	23.8	22.4	130	359	53	289	21.5	26.3
T_3	0.82	0.68	0.26	0.11	0.31	0.86	23.6	21.6	128	354	52	286	20.5	25.4
T_4	0.86	0.72	0.3	0.12	0.35	0.82	22.4	19.0	123	350	50.1	210	19.2	26.4
T_5	0.80	0.72	0.28	0.10	0.31	0.90	22.7	19.5	124	349	50.1	212	19.0	25.7
T_6	1.02	0.96	0.36	0.14	0.37	1.07	22.4	25.1	131	353	50.4	209	18.0	25.9
T_7	0.98	0.86	0.31	0.12	0.32	0.82	22.5	24.3	129	348	51.0	212	18.2	25.5
T_8	0.91	0.90	0.32	0.13	0.36	0.82	22.7	24.8	128	354	52.2	214	18.0	25.8
T_9	1.14	1.09	0.39	0.15	0.43	1.26	26.9	28.8	139	361	56.3	299	19.5	27.6
T_{10}	1.10	1.07	0.38	0.14	0.38	1.26	26.34	26.4	134	359	53.0	296	19.4	26.9
T_{11}	1.10	1.07	0.40	0.15	0.42	1.26	26.8	27.9	138	357	55.0	294	19.7	27.2
T_{12}	0.98	0.98	0.37	0.13	0.38	0.91	26.5	28.0	134	360	54.0	292	19.4	26.8
T_{13}	1.12	1.00	0.39	0.13	0.42	1.13	26.4	28.4	138	361	56.0	298	19.5	27.6
T_{14}	1.11	0.98	0.38	0.13	0.40	1.13	26.4	28.6	135	360	54.0	293	19.4	27.5
SEm	0.065	0.026	0.004	0.005	0.02	0.016	0.273	1.170	1.194	4.868	3.16	2.896	0.31	0.32
CD at 5%	0.189	0.077	0.012	0.015	0.05	0.046	0.793	3.39	3.456	14.10	9.16	8.387	0.92	0.91

Table 3 : Effect of phosphorus levels and organic manures on micronutrient uptake in paddy

Treatments	Zn (mg pot^{-1})		Fe (mg pot^{-1})		Mn (mg pot^{-1})		Cu (mg pot^{-1})	
	Grain	Straw	Grain	Straw	Grain	Straw	Grain	Straw
T_1	136	171	0.72	2.83	0.29	1.76	107	213
T_2	259	308	1.41	4.94	0.54	3.98	232	374
T_3	221	251	1.17	4.09	0.49	3.32	191	312
T_4	297	283	1.62	5.23	0.65	3.16	254	362
T_5	176	206	0.95	3.72	0.40	2.27	155	267
T_6	390	492	2.31	6.93	0.89	4.09	317	442
T_7	286	371	1.64	5.12	0.64	3.32	234	343
T_8	316	383	1.75	5.48	0.72	3.31	251	364
T_9	735	882	3.80	11.09	1.54	9.82	535	785
T_{10}	562	617	2.85	8.35	1.13	6.89	415	573
T_{11}	708	813	3.62	10.38	1.47	8.57	520	772
T_{12}	386	486	1.93	7.86	0.79	5.76	281	512
T_{13}	667	814	3.44	10.32	1.39	8.52	487	764
T_{14}	403	492	2.07	8.24	0.84	5.60	295	520
SEm	14.62	13.64	0.02	0.30	0.02	0.17	17.65	9.43
CD at 5%	42.33	39.52	0.05	0.87	0.05	0.48	51.10	27.32

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