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Phosphorus Transformation Status of *Typics ustipsamments* Taxonomy under *In-vitro* Condition

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Abstract

Incubation study was carried out in the Laboratory of Department of Agricultural Chemistry and Soil Science, C.P. College of Agriculture, S.D. Agricultural University, Sardarkrushinagar. Treatments comprising of three levels of moisture regimes, three levels of P of two P carriers, two levels of FYM and five incubation intervals were evaluated under completely randomized design (with factorial concept) with three replications. Available P_2O_5 content in soil was increased significantly with application of FYM @ 10 t/ha with 2.68 mg P/ 100 g soil and maintenance of moisture at 25% available water capacity was found significantly higher as compared to without FYM. Available P_2O_5 increased up to 3rd DAI then decreased with respect to phosphorus availability in loamy sand. Under the different forms of phosphorus, maintenance of moisture at 100 % available water capacity, FYM @ 10 t/ha and P 2.68 mg P/ 100 g soil increased the inorganic-P and total-P up to 14th DAI.

1. Introduction

Soils are known to vary widely in their capacities to supply P to crops because only a small fraction (> 1-3 %) of the total P in any soil is in a form that is available to plants (Table 1). Thus, unless the soil contains adequate amount of plant available P ($H_2PO_4^-$, HPO_4^{2-} or PO_4^{3-}) depends on soil pH, crop growth will suffer. The immobile properties of P can be exploited by mobilizing native plant unavailable P to available form so that we may recycled the native P and minimize or omit P fertilization from outside sources resulted to save rock phosphate reserve and huge amount of money spending for importing raw materials *viz*., rock phosphate, phosphoric acid, sulphuric acid, sulphur, etc. for preparation of Phosphate fertilizers.

Table 1: Phosphorus scenario in Indian soil (Patel et al., 2019)

Form of phosphorus	All India (%)	Arid region (%)
Plant available form	> 1-3	0.8-1.6
Unavailable inorganic form	15-79	75-79
Organic form	18-90	18-22

The texture of a soil determines the, rate and amount of fixation of P. To some extent, it also governs the mineral forms of P in which it is fixed. Silty clay loam texture soil observed higher applied P in the form of Fe-P. As against this, clay loam texture soil showed more concentration of applied P in the form Ca-P (Dhar and Saxena, 1966).

The pit of a soil governs the cationic species present in the soil solution. Usually, the predominance of Ca ions is observed in neutral to slightly alkaline soils whereas, Fe and Al ions predominate in an acidic soil. When a soluble form of P is added in these soils, the conversion takes place. Maximum fixation of available P as Ca-P in neutral to slightly alkaline soils while, fixation as Fe-P was maximum in acid soil (Dhua and Joshi, 1972).

Moisture status of a soils affects the redox potential which, in turn, affects the concentration of reducible ion, that is Fe or Fe_2O_3 and hence variation in this form of P observed under different moisture conditions. Mandal and Khan (1977) observed dominance of Al-P under saturated conditions whereas Fe-P was found to dominate under waterlogged conditions. The concentration of Ca-P was almost identical both under saturated as well as waterlogged conditions.

The source in which the P is added also affects the transformation of P in various categories. The studies (Misra and Ojha, 1968) showed more concentration of P in Al-P with KH_2PO_4 as the source of P. However, when $NH_4H_2PO_4$ was the source more concentration as Ca-P was observed.

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Similarly, the rate of addition of P in the soil also affects the transformation of P. Almost identical concentration of P as Ca-P with each increasing rates of added P. However, the concentration of P as Fe-P and Al-P increased linearly with rate of addition of P.

2. Materials and Methods

2.1 Physico-Chemical Properties of Soil

The representative soil sample was analyzed for different physico-chemical characteristics. The soil of the experimental site was loamy sand in texture. The soil was low in organic carbon and available nitrogen, medium in available P_2O_5, K_2O

Table 2: Initial physico-chemical properties of the soil under incubation study

Physico-chemical properties	Values
EC (1:2.5) dS/m at 25°C	0.18
pH (1:2.5) at 25 °C	7.50
Organic carbon (%)	0.23
Available N (kg/ha)	209.36
Available P_2O_5 (kg/ha)	33.15
Available K_2O (kg/ha)	231.78
Bulk density (Mg/m3)	1.65
M.W.H.C. (%)	22.12

2.2 Details of Incubation Study

[1]	Moisture regimes : 03		
	W_1	=	100 % Available water capacity
	W_2	=	50 % Available water capacity
	W_3	=	25 % Available water capacity
[2]	Levels of P : 03		
	P_0	=	0.00 mg P/100 g soil
	P^1	=	1.34 mg P/100 g soil
	P_2	=	2.68 mg P/100 g soil
[3]	Sources of P : 02		
	S_1	=	MAP
	S_2	=	DAP
[4]	FYM : 02		
	M_0	=	0 t/ha
	M_1	=	10 t/ha
[5]	Incubation intervals : 05		
	I_0	=	01 day
	I_1	=	03 day
	I_2	=	05 day
	I_3	=	07 day
	I_4	=	14 day

Design	:	CRD (With Factorial Concept)
Number of repetitions	:	03
Number of treatment combinations	:	36
Total number of experi-mental beakers or units	:	540

2.3 Phosphorus Fractions

The total-P was determined by digesting 1.0 g of 0.15 mm sieved oven dried soil with HNO_3 and $HClO_4$ acids and then followed vanadomolybdate method (Hesse, 1971). The inorganic-P was extracted with concentrated HCl (Hesse, 1971) and the P in solution was determined with cholorotanuous reduced molybdophosphoric blue colour method in HCl system (Jackson, 1978). The difference between total and inorganic-P was reported as organic-P. The fractions of the inorganic-P, which includes Saloid bound-P, Al-P, Fe-P, Reductant soluble-P, Occluded-P and Calcium-P was extracted successively by the method of Chang and Jackson (Petersen and Corey, 1966) and the blue colour was also developed as described by them.

3. Results and Discussion

3.1 Status of Different Forms of Soil Phosphorus (%)

Phosphorus, like any other plant nutrient is present in soil in two major components i.e. organic and inorganic. Organic P, which is mainly confined to the surface layer, is mineralized into inorganic forms. But the plants mainly depend on inorganic P forms for their P requirements. saloid-P, Al-P, Fe-P, Ca-P, occluded-P and reductant-P fractions are the main source of P supply to the plants. The proportion of forms of phosphorus such as Ca-P, Al-P, Fe-P, occluded-P, reductant-P and organic-P governs the response to applied P (Singh *et al*., 2003).

The amount of P recovered under various fractions varied considerably depending upon the treatments given during incubation study. All P fractions *viz*., saloid-P, Al-P, Fe-P, Ca-P, occluded-P, reductant-P and organic-P increased, when moisture level (100% available water capacity), phosphatic fertilizers were applied at higher levels (2.68 mg P/ 100 g soil) either alone or in combination with organics during incubation study. The application without P fertilization did not influence soil P fractions, as under 0.00 mg P/ 100 g soil treatment.

The Ca-P (40.72%) was the major inorganic P fraction in all the forms of phosphorus because calcareous soils are reported to have large amounts of P as Ca-P, irrespective of nature and kind of added fertilizer due to the more stabilized nature of calcium system under high pH (Jaggi, 1991). Ca-P with application of all treatment combination increased 38.3 percent, over occluded-P content as a result of mean basis. Whereas, lowest involvement of occluded-P content (2.42%) in total-P. The concentration and contribution of each fraction to total-P was in the order: occluded-P < Al-P < saloid-P < reductant-P < Fe-P < organic-P < Ca-P.

Table 3: Effect of moisture regimes, FYM and levels of P carriers on percent wise involvement of different phosphorus fraction in total-P in soil at different intervals of incubation

Different phosphorus fraction in total-P (%)						
Parameters	1st DAI	3rd DAI	5th DAI	7th DAI	14th DAI	Mean
Saloid-P	9.02	7.70	6.62	5.64	4.68	6.73
Al-P	5.26	4.86	5.44	6.10	6.71	5.68
Fe-P	13.98	13.75	13.93	14.57	14.90	14.23
Ca-P	40.53	41.60	40.14	40.05	41.26	40.72
Occluded-P	2.54	2.52	2.58	2.38	2.08	2.42
Reductant-P	7.58	7.90	8.78	8.94	9.17	8.47
Organic-P	21.09	21.66	22.50	22.32	21.19	21.75

4. Conclusion

Under the different forms of phosphorus, maintenance of moisture at 100% available water capacity, FYM @ 10 t/ha and P 2.68 mg P/ 100 g soil increased the inorganic-P and total-P upto 14th DAI.

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