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Contribution of the Different Enzymes on Mobilization of Phosphorus in Alfisols and Inceptisols Soils of Rajasthan

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Abstract **- Field study was carried out to assess the contribution of the different enzymes on mobilization of phosphorus. Wheat, Maize, Sorghum and Mustard in rhizosphere and non-rhizosphere of plants under Alfisols and Inceptisols. A significant (p=0.05) difference in dehydrogenase, acid phosphatase, biomass carbon, biomass P and phytase by different plant species were observed between the soils under study.**

Keywords **– Microorganism, Phosphoru S Mobilization, Soils.**

I. Introduction

Phosphorus is an important nutrient in crop production. It promotes root growth and helps in energy transformation as well as photosynthesis in plant. The function of phosphorus as a constituent of macromolecular structures especially in nucleic acids, found in DNA and RNA is well known. However, being immobile largely, its remains unavailable to the plants. The P cycle in soil is a dynamic system involving soils, plants and microorganisms. It passes through utilization by plants biological return through plant and animal residues, mineralization-immobilization, and solubilization through the activities of microorganisms. Chemical and biochemical aspects of the P cycle have been studied by many workers such as (Richey, 1983, Walker, 1964, Mengel and Kirkby, 1982, Khasawneh et al., 1980 and Anderson, 1980)

II. Material and Method

The present investigation was undertaken under two soil orders of Alfisols and Inceptisols. The soils of these two orders are found dominating in the maximum parts of Rajasthan. Four crops viz. Maize, Sorghum, Wheat and Mustard were used as test crops to see the efficacy of influencing mobilization of P for plants. Soil samples from the rhizosphere and non-rhizosphere of the crop were collected. These samples were analyzed for P-mobilization at different crop growth stages.

1. Dehydrogenase

Dehydrogenase activity was assay as per the method as suggested by Tabatabai (1982) was followed for the purpose.

2. Acid phosphatase

The acid phosphatase activity was analyzed by adopting the standard procedure as per the method as suggested by Tabatabai and Bremner (1969).

3. Biomass carbon

The biomass carbon was analyzed by adopting the standard procedure as per the method as suggested by Vance et al (1987).

4. Biomass P

The biomass P was analyzed by adopting the standard procedure as per the method as suggested by Bowman & Cole (1979).

5. Phytase activity

Phytase activity was assay following the method as reported by Ames (1966).

III. Results and Discussion

Dehydrogenase Activity:

The dehydrogenase activity of the soils under study (i.e., alfisols and inceptisols) were found significantly differ (p=0.05) under different plant species with maximum under mustard followed by sorghum, maize and the least in wheat (Table 1) Although, the rhizosphere and non-rhizosphere effect was found no-significant under all the plant species under individual soil type except at harvest under mustard in both alfisols as well as inceptisols. Slightly higher dehydrogenase activity was observed under rhizosphere than non-rhizosphere which might be attributable to root effects of different plant species. Generally, Dehydrogenase activity was higher under inceptisols than alfisols. However, the buildup of dehydrogenase activity was higher under alfisols than inceptisols under all the plant species which was considerably altered at different plant growth stages.

Acid phosphates

A critical assessment of results presented in table 2 reveals a significant improvement of 23.7 and 19.0 in rhizosphere of alfisols and inceptisols, respectively where as 14.3% and 78.50 in non-rhizosphere of alfisols and inceptisols, in activity of acid phosphate in mustard at sowing. Higher increase was under rhizosphere than non-rhizosphere ones. Further, improvement was more in inceptisols than alfisols. In contrary to it in crops like wheat, maize and sorghum a reverse trend in acid phosphatase was noted. A marked decrease in acid phosphatase levels at harvest indicates a sign of its important in P mobilization. It may be due to maximum root growth were found up to 45 DAS after that root degradation will be started up to harvest. Acid phosphatase secretion was directly correlated with the root growth and root biomass. Such results have also been reported by (Yadav and Tarafdar, 2010, Dave et al, 2008, and Tarafdar and Jungk, 1987)

Biomass carbon

An appraisal of biomass carbon presented in table.3 shows that irrespective of soil types and sampling site (ie, rhizosphere and non-rhizosphere) significant (p=0.05) increase biomass carbon was recorded and found altered the most at 45 DAS of crop. The maximum buildup of biomass carbon was recorded in sorghum followed by maize, mustard and wheat, in rhizosphere than non-rhizosphere. Further higher contents of biomass carbon at 45 DAS and indicates of good microbial soil health for better P mobilization in both the soil types. Crops having more root length density and surface area (like Sorghum, maize and wheat) also might favoured the improvement of biomass-carbon (5.423, 6.910 at 45 DAS in Alfisols and Inceptisols respectively) higher biomass carbon under the sorghum crop.

Biomass P

Results presented in table.4 show a significant increase in biomass P in rhizosphere soils, whereas a decrease trend was observed in non-rhizosphere, irrespective of all the crops. Among all the crops taken under study the biomass P was found in order of a trend of sorghum> maize>mustard>wheat. The maximum 5.423 mg/Kg biomass P was noted in sorghum at 45 DAS and minimum (4.80 mg/Kg) in wheat, whereas the maximum (6.910 mg/Kg) in sorghum and the minimum 6.101 mg/Kg in rhizosphere of alfisols and inceptisols, respectively. A marked decline in biomass P in non-rhizosphere soil from 45 DAS to harvest stage was noted under all the crops. Further, decrease in biomass P in non-rhizosphere as compared to rhizosphere might be due to contribution of microbes in various crops and soils under study. It may be due to 33 to 50% contributed of rhizosphere in biomass P which could play an important role in mobilization of phosphorus in all the crops under study.

The ability of soil microorganisms in solubilizing various forms of precipitated P is well documented by (Saini et al, 2005, Kumar et al., 2007, Dave et al, 2008, Yadav and Tarafdar, 2009, Verma et al., 2010, Yadav and Tarafdar, 2010,). The importance of soil microorganisms for increasing the available P from phytate and glycerophosphate to plant roots has similarly been pointed by Tarafdar and Marschner (1995).

Phytase activity

An appraisal of phytase activity results presented in table 5 shows that irrespective of soil types and sampling site (i.e., rhizosphere and non-rhizosphere) a significant (P=0.05) increase in phytase activity was recorded which increased to at 45 DAS of crop growth compared to other growth stages. Higher contents of phytase activity at 45 DAS and at harvest than initial level. This trend was found due to slower microbial activity at initial stage as compared to later stages of crops. The higher phytase activity is responsible for P-mobilization, which is a sign of healthy microbial activity in the soils, further higher phytase activity in sorghum, wheat, maize crops in comparison to mustard crop is due to the high density and surface area of the roots.

REFERENCE

[1] Richey, J.C. (1983). The phosphorus Cycle. In: The Major Biogeochemical Cycles and Their Interactions, Bolin, B. and Cook, R.B. (eds), John Wiley, New York. p 51-56.

[2] Walker, 2T.W. (1964). The significance of phosphorus in pedogenesis. In: *Experimental Pedology*, Easter School in Agricultural Sciences, University of Nottingham. p 295-316.

[3] Mengel, E. and Krikby, E.A. (1982). Principles of Plant Nutrition, (II[nd] eds). International Potash Institute, Bern, Switzerland.

[4] Khasawneh, F.E., Sample, E.C. and Kamprath, E.J. (1980). The Role of Phosphorus in Agriculture. *American Society of Agronomy* (eds.), Madison, Wisconsi

[5] Anderson, G. (1980). Assessing organic phosphorus in soils. In: *The role of Phosphorus in Agriculture*, Khasawneh, F.E., Sample, E.C. and Kamprath, E.J. (eds.). *American Society of Agronomy*, Madison, p 411-432.

[6] Gerke, J. (1992). Orthophosphate and organic phosphate in the soil solution of four Sandy Soils in relation to pH-evidence for humic-Fe-(Al-) Phosphate Complexes. *Soil Science & Plant analysis* 23 : 601-612.

[7] Dalal, R.C. (1978). Organic Phosphorus. *Advance Agronomy*. 29:83-117

[8] Tarafdar, J.C. and Jungk, A. (1987). Phosphatase activity in the rhizosphere and its relation to

[9] the depletion of soil organic phosphorus. *Biology and Fertility of Soils* 3: 199-204.

[10] Saini, V.K., Bhandari, S.C. and Panwar, J. (2005). Establishment and influence of different

[11] microbial inoculants along with FYM and biofertilizer on the performance of *Sorghum bicolor* L. *Indian Journal of Microbiology*, 45 (2): 147-150

[12] Kumar, P., Kathju, S., Panwar, J., Saini, V.K. and Tarafdar, J.C. (2007). Dehydrogenase

[13] and phosphatase activities in soil under arid ecosystems as influenced by tillage, soil depth and crop rotation. *Journal of the Indian Society of Soil Science* 55, 488-492.

[14] Dave, S., Yadav, B.K. and Tarafdar, J.C. (2008). Phytase phosphorus and mineral changes

[15] during soaking, boiling and germination of legumes and pearl millet. *Journal of Food Science and Technology* 45, 344-348.

[16] Yadav, B.K. and Tarafdar, J.C. (2009). Extracelular acid phosphatase and phytase activities

[17] of buffel brass (*Cenchrus ciliaris* L.) genotypes. *Journal of the Indian Society of Soil*

[18] *Science* 57, 332-337

[19] Verma, N., Tarafdar, J.C. and Srivastava, K.K. (2010). Periodic changes in *Prosopis*

[20] *Cineraria* associated AM population at different soil depth and its relationship with organic carbon and soil moisture. *African Journal of Microbiology Research* 4, 115-121.

[21] Yadav, B. K. and Tarafdar, J. C. (2010). Studies on phosphatases activity and clusterbean

[22] production as influenced by the P mobilization organism *Emericella rugulosa*. *Legume Research* 33, 114-118.

[23] Tarafdar, J. C. and Marschner, H. (1995). Dual inoculation with *Aspergillus fumigatus* and *Glomus mossae* enhances biomass production and nutrient uptake in wheat (*Triticum aestivum* L.) supplied with organic phosphorus as Na-phytate. *Plant and Soil* 173: 97-10

[24] Ames, B. N. (1966). Assay of inorganic phosphate, total phosphate and phosphatases. *Methods in Enzymology* 8: 115-118.

[25] Tabatabai M.A. and Bremner J.M. (1969). Use of p-nitrophneyl phosphate for assay of phosphatase activity. *Soil Biol. Biochemic. 1, 301*

[26] Jackson, M.L. (1967). Soil Chemical Analysis. Prentice-Hall of India, Delhi. p 498.

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Table 1: Effect of rhizosphere & non- rhizosphere on Dehydrogenase (pKat/ gm soil) under different crops

Treatment	Wheat			Mustard			Maize			Sorghum		
	Before sowing	45DAY	After harvest	Before sowing	45DAY	After harvest	Before sowing	45DAY	After harvest	Before sowing	45DAY	After harvest
Alfisol (R)	1.285	1.668	1.170	1.450	3.040	1.170	1.405	1.680	1.170	1.645	1.753	1.170
(NR)	1.790	1.488	1.176	1.348	2.291	1.176	1.258	1.520	1.176	1.545	1.613	1.176
Inceptisol(R)	1.688	2.145	1.676	1.815	3.409	1.688	2.090	2.300	1.688	2.113	2.440	1.688
(NR)	1.360	1.931	1.683	1.603	2.269	1.683	1.868	2.127	1.683	1.968	2.174	1.683
SEm±	0.12	0.15	0.06	0.16	0.04	0.06	0.10	0.15	0.06	0.14	0.14	0.06
CD(p=0.05)	0.38	0.46	0.18	0.48	0.11	0.18	0.31	0.45	0.18	0.42	0.43	0.18

Table.2 Effect of rhizosphere & non- rhizosphere on Acid Phosphatase (mg/kg) under different crops

Treatment	Wheat			Mustard			Maize			Sorghum		
	Before sowing	45DAY	After harvest	Before sowing	45DAY	After harvest	Before sowing	45DAY	After harvest	Before sowing	45DAY	After harvest
Alfisol (R)	0.708	0.885	0.505	0.885	1.095	0.825	0.478	0.885	0.313	0.413	0.885	0.343
(NR)	0.630	0.888	0.455	0.888	1.015	0.748	0.413	0.888	0.268	0.343	0.888	0.268
Inceptisol(R)	0.615	0.885	0.308	0.885	1.580	1.025	0.695	0.885	0.425	0.610	0.885	0.435
(NR)	0.490	0.883	0.258	0.883	1.435	0.928	0.650	0.883	0.358	0.510	0.883	0.285
SEm±	0.06	0.06	0.08	0.06	0.12	0.08	0.06	0.06	0.02	0.05	0.06	0.05
CD(p=0.05)	0.18	0.17	0.25	0.17	0.36	0.25	0.18	0.17	0.08	0.15	0.17	0.15

Table 3: Effect of rhizosphere & non- rhizosphere on Biomass- P (mg/kg) under different crops.

Treatment	Wheat			Mustard			Maize			Sorghum		
	Before sowing	45DAY	After harvest	Before sowing	45DAY	After harvest	Before sowing	45DAY	After harvest	Before sowing	45DAY	After harvest
Alfisol (R)	0.226	0.335	0.188	0.254	0.370	0.188	0.340	0.370	0.188	0.350	0.402	0.188
(NR)	0.204	0.280	0.187	0.230	0.270	0.187	0.300	0.330	0.187	0.310	0.340	0.187
Inceptisol(R)	0.316	0.420	0.240	0.330	0.430	0.240	0.420	0.470	0.240	0.440	0.563	0.240
(NR)	0.280	0.330	0.248	0.290	0.330	0.248	0.390	0.420	0.248	0.400	0.460	0.248
SEm±	0.013	0.013	0.006	0.018	0.006	0.006	0.005	0.006	0.006	0.005	0.020	0.006
CD(p=0.05)	0.040	0.041	0.018	0.055	0.019	0.018	0.016	0.018	0.018	0.015	0.060	0.018

Table 4: Effect of rhizosphere & non- rhizosphere on Biomass - C (mg/kg) under different crops

Treatment	Wheat			Mustard			Maize			Sorghum		
	Before sowing	45DAY	After harvest	Before sowing	45DAY	After harvest	Before sowing	45DAY	After harvest	Before sowing	45DAY	After harvest
Alfisol (R)	4.200	4.800	3.600	4.210	4.921	3.600	4.890	5.130	3.600	4.920	5.423	3.600
(NR)	3.400	3.199	3.620	3.400	3.110	3.610	3.398	3.039	3.610	3.391	2.910	3.610
Inceptisol (R)	5.690	6.101	4.680	5.750	6.339	4.680	6.101	6.561	4.680	6.209	6.910	4.680
(NR)	4.720	4.439	4.680	4.600	4.188	4.669	4.309	4.008	4.669	4.030	3.822	4.669
SEm±	0.06	0.08	0.06	0.07	0.08	0.05	0.06	0.07	0.05	0.06	0.08	0.05
CD(p=0.05)	0.20	0.24	0.18	0.21	0.23	0.16	0.18	0.21	0.16	0.19	0.24	0.16

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Table 5: Effect of rhizosphere and non- rhizosphere on Phytase (mg kg^{-1}) under different crops

Treatment	Wheat			Mustard			Maize			Sorghum		
	Before sowing	45DAY	After harvest	Before sowing	45DAY	After harvest	Before sowing	45DAY	After harvest	Before sowing	45DAY	After harvest
Alfisol (R)	1.150	3.700	3.920	1.150	2.920	3.670	1.220	3.500	3.990	1.220	3.738	4.420
(NR)	1.150	2.890	3.030	1.150	1.860	2.100	1.220	2.310	2.620	1.220	2.510	2.998
Inceptisol (R)	2.040	4.200	4.920	1.700	3.360	3.720	1.950	4.220	5.000	1.950	4.820	6.169
(NR)	2.040	3.050	3.190	1.700	2.909	3.069	1.950	3.010	3.810	1.950	3.100	4.020
SEm±	0.02	0.06	0.07	0.02	0.05	0.06	0.02	0.05	0.07	0.03	0.06	0.07
CD(p=0.05)	0.07	0.18	0.23	0.06	0.15	0.18	0.07	0.15	0.21	0.11	0.18	0.21

R : Rhizosphere; NR : Non- rhizosphere