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Original Research Article

Physico-Chemical Properties of Acid Alfisol as Influenced by Different Cropping Systems

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A B S T R A C T

Experiment was carried out with soils of different cropping systems (rice-fallow, vegetable-vegetable, rice -wheat and rice-rice) prevalent in Jharkhand to assess the status of soil phosphorus and its relation with soil properties. Among all cropping systems, rice- rice cropping systems had registered high pH, organic carbon, exchangeable Ca^{+2},Mg^{+2},K^{+}, total and available P and lowest sesquioxide. Rice-fallow and rice-wheat cropping systems had high mean value of sesquioxide i.e. 9.42% and 8.99% respectively. In all the cropping systems, total P was positively correlated with sesquioxide and clay content whereas available P was negatively correlated. Positive correlation was noted in available P with pH and organic carbon.

Keywords

Cropping systems, sesquioxide, phosphorus

Introduction

Physico-chemical properties of soil viz. pH, organic carbon, exchangeable Ca^{+2},Mg^{+2},K^{+}, sesquioxide, total and available P played an important role in sustaining crop productivity. Different cropping systems require different environments, i.e. rice prefer reduced conditions whereas wheat, vegetable prefer oxidized conditions. Also, some of the agronomic practices like periodic sub-mergence, puddling and drying of soils that are performed during rice cultivation adversely affect soil properties. Different crop remove different amount of nutrients from soil to produce same amount of economic produce (Tandon 1992). Therefore, depletion of soil fertility is different for different cropping systems. Keeping this in view, the present study was carried out to evaluate the changes in Physico-chemical characteristics of soil under different cropping systems and its correlation with phosphorus present in the soil.

Materials and Methods

General characteristics of study area

The study area was located between 23^{o} 03^{l} to23^{o} 33 ^{l} N Latitude and $85^{o}17^{l}$ to 86^{o} 12^{l} E-Longitude with altitude ranging from

600 to 675 m above mean sea level. Forty soil samples (0-15 cm) were collected after harvest. Ten soil samples from each cropping systems (Rice-fellow, vegetable-vegetable, rice -wheat and rice-rice)from the different locations of farmers field (Bukru, Pithoria and Borya from Ranchi dristrict and Chandil of East Singhbhum).

Soil samples were air dried, ground in wooden pestle and mortar. These ground soil samples were passed through 2mm sieve. Processed soil samples were kept in poly bag for further analysis. Soil samples were analyzed for pH, organic carbon, available P (Bray's $P_{1,}$Bray's P_2 and Olson'P), sesquioxide, Clay, exchangeable Ca^{+2}, Mg^{+2} and K^+ (Jackson, 1973).

Results and Discussion

The highest mean value of pH 6.4(Table-1)was observed in soils under rice-rice system followed by soils of vegetable-vegetable system. The rice-fallow and rice-wheat systems exhibited practically similar mean values of 5.5. The highest mean value of pH under rice-rice may be attributed due to prolong submergence, which might have favoured the reaction process especially of iron (Ponnamperuma, 1966 and Dekamedhi and Datta, 1995). The pH value of soil under vegetable-vegetable system is higher than rice- wheat and rice- fallow systems. This may be due to continuous application of FYM in vegetable-vegetable system which might have greater effect in stabilization of pH as compared to application of fertilizer alone in rice-wheat and rice- fallow systems. Among all the prevalent cropping systems under study given in table-1, organic carbon content of soil in rice-rice cropping system was found highest (0.75%). This may be due to continuous submergence and lower oxidation rate of added organic matter through crop roots and stubbles. Similar observation was recorded by Mukherji and Mandal (1995).

Rice-rice cropping system had lowest mean value of sesquioxide (6.82%) followed by vegetable-vegetable (6.98%), rice- wheat (8.99%) and rice-fallow(9.42%) system. Lower value of sesquioxide was recorded in Rice-rice and vegetable-vegetable system due to higher pH and lower levels of oxidation. In submerged soil (rice-rice cropping system)possibly reduction of Fe^{+3} and precipitation of Fe^{+2}as $Fe_3(OH)_6$ and FeS might have resulted in lower values of sesquioxide (Ponnamperuma, 1985 and Dekamedhi and Datta, 1995). Rice-fallow and rice -wheat have higher mean value of sesquioxide in comparison to rice-rice and vegetable-vegetable system. In such systems lower pH and higher oxidizing environment may be attributed to such variation in the sesquioxide content.

The highest mean values of Ca^{+2}, $Mg^{+2}$and K^+ were observed in soils under rice-rice cropping system which remained under submergence for longer duration. The increase in availability of Ca^{+2} and Mg^{+2} under submerged condition might be either due to solvent action of CO_2 or cation exchange reaction (Mukherjee and Mandal, 1995).

Vegetable-vegetable growing system have higher mean value of exchangeable Ca^{+2},Mg^{+2} and K^+ as compared to rice-wheat and rice-fallow cropping system because vegetable-vegetable growing soils were reach in organic matter.

Table.1 pH, Organic carbon(%) and sesquioxide(%) content of soil as influenced by different cropping system.

Cropping system	pH			Organic carbon(%)			Sesquioxide(%)		
	Range	Mean	S.D	Range	Mean	S.D	Range	Mean	S.D
Rice-fellow	5.0-6.3	5.5	± 0.38	0.28-1.20	0.41	± 0.25	6.4-13.6	9.42	± 2.35
Vegetable-vegetable	5.0-6.8	5.8	± 0.61	0.27-0.58	0.45	± 0.11	5.5-10.0	6.98	± 1.79
Rice-rice	5.4-7.0	6.4	± 0.43	0.33-1.33	0.75	± 0.43	5.0-11.5	6.82	± 2.07
Rice-wheat	5.1-6.5	5.5	± 0.46	0.25-0.52	0.38	± 0.10	6.3-10.0	8.99	± 1.40

Table.2 Exchangeable Ca^{+2}, Mg^{+2}, K^{+} and clay contents of soil as influenced by different cropping systems

Cropping system	Exchangeable cations [C mol(P^{+})Kg^{-1}									Clay(%)		
	Ca^{+2}			Mg^{+2}			K^{+}					
	Range	Mean	S.D	Range	Mean	S.D	Range	Mean	S.D	Range	Mean	S.D
Rice-fellow	2.25-5.75	3.29	±0.99	0.75-2.00	1.55	±0.44	0.06-0.09	0.18	±0.01	14.0-24.8	19.4	±2.8
Vegetable-vegetable	2.70-7.50	4.12	±1.40	0.75-3.50	2.03	±0.84	0.09-0.20	0.14	±0.03	17.0-24.4	21.4	±1.8
Rice-rice	2.00-8.75	5.13	±1.88	0.75-3.25	2.05	±0.67	0.11-0.32	0.18	±0.07	17.0-25.3	21.7	±2.4
Rice-wheat	1.25-5.25	2.76	±1.24	0.45-1.50	0.78	±0.33	0.12-0.16	0.13	±0.01	17.0-25.0	21.5	±2.5

Table.3 Total and available P status (ppm) of soil under different cropping systems

Cropping system	Total P (ppm)			Available P (ppm)								
				Bray's P_1			Bray's P_2			Olsen's P		
	Range	Mean	S.D	Range	Mean	S.D	Range	Mean	S.D	Range	Mean	S.D
Rice-fallow	398-563	504.70	±60.54	9.50-16.50	13.10	±2.37	32.50-54.00	43.95	±7.38	3.80-7.00	5.35	±1.19
Vegetable-vegetable	338-539	424.10	±70.17	10.00-18.50	15.08	±3.13	35.00-60.00	49.60	±8.86	4.50-7.50	5.80	±1.00
Rice-rice	369-644	533.00	±92.04	7.00-19.50	15.10	±3.04	35.50-62.00	49.58	±9.20	4.50-8.50	5.84	±1.27
Rice-wheat	285-619	484.90	±112.87	7.50-18.50	12.10	±3.11	27.50-61.50	40.55	±10.10	3.20-6.50	4.53	±1.00

Table.4 Correlation between soil properties with total and available P indices

	pH	Organic carbon	Sesquioxide	Clay
Total P	-0.258	-0.343	0.687**	0.588**
Bray'sP$_1$ (Available P)	0.420*	0.368*	-0.817**	-0.706**
Bray'sP$_2$	0.379*	0.335	-0.805**	-0.704**
Olsen's P	0.476**	0.469**	-0.741**	-0.741**

* Significant at 5% level, **Significant at 1% level

Higher soil status of exchangeable Ca^{+2} and Mg^{+2} in soils may be explained in the light of lower losses due to higher binding ability of organic matter (Singh, 1990). The improvement in exchangeable K^{+} in organic matter treated plots is in conformity with the findings of Singh (1990).

From the data presented in table-4,it was observed that sesquioxide is significantly and positively correlated with total P. Tomar (2000) also found similar results. Total P was also positively correlated with clay content and negatively with pH. This finding is supported by Loganathan and Suttan (1987). Total P is negatively and significantly correlated with organic carbon. Mohan(1995) also reported similar results. Available P in soil was significantly and negatively correlated with sesquioxide and claycontent in soil. This may be due to higher transformation of added P into insoluble compounds of Al and Fe with increasing sesquioxide. This finding was also supported by Tomar (2000). Clay content increases P fixation by providing sites or surface area for sorption, resulting in decreased P availability. This finding was reported by Tek Chand and Tomar (1995).

Finally, it can be concluded that among the different cropping systems vegetable-vegetable system and rice-rice system had higher available P (15.0&13.10 ppm respectively). This may be due to higher value of pH and organic carbon in comparison to others. It was observed that available P of soils under different cropping systems were significantly and positively correlated with pH and organic carbon. In acid soil, increase in pH increases net negative charge and decreases the activity of Al^{+3} and Fe^{+3} (Tomar,2000) thereby reduction of P adsorption and enhancement of P availability with organic carbon was due to mineralization of organic P and solubilization of native inorganic phosphorus and lower fixation of added P (Tomar, 2000).

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