IJCRT.ORG ISSN : 2320-2882

INTERNATIONAL JOURNAL OF CREATIVE RESEARCH THOUGHTS (IJCRT)

An International Open Access, Peer-reviewed, Refereed Journal

PHOSPHORUS FRACTION AND THEIR RELATIONSHIP WITH PHYSICOCHEMICAL PROPERTIES OF SURFACE SOIL OF VARANASI RESION(U.P.)

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ABSTRACT

A lab study was conducted to fractionate the soil P and find the relationship of different P fraction with physicochemical properties of surface soil of Varanasi region (U.P.) in the laboratory of agricultural chemistry and soil science department Udai Pratap college Varanasi. Most of the soils were light textured Soils from seven different region were collected and analyzed for phosphorus (P) fraction. The soils were neutral to slight alkaline in nature. The electrical conductivity (EC) ranged from 1.46 to 3.50 dS/m. The bulk density varied from 1.18 to 1.46 Mg/m^3. The organic carbon values ranged from 0.50 to o.75 %. The highest value was observed in DLW in surface soils .The distribution of the different forms of the phosphorus fraction was as Saloid-P (23.43 to 44.62 ppm), Al-P(10.75 to 20.02 ppm), Fe-P (6.96 to 13.4 ppm), Ca-P (80.97 to 115.78 ppm), reductant soluble-P (10.68 to 27.70 ppm), occluded-Al-Fe-P (13.02 to 26.75 ppm), organic-P (81.41 to 172.32ppm) with total phosphorus(270.75 to 383.84ppm) in different surface soils.The highest amount of Saloid -P, Ca-P, and lowest of Fe-P, Al-P, Organic-P. Among the different P fractions Ca-P was dominant fraction followed by saloid-P, reductant soluble-P, Al-P and Fe-P.

Key words- Phosphorus fractionation, Calcium, Fe, Al

Introduction:

Phosphorus is one of the essential plant nutrients for plant growth and is of particular interest in highly weathered tropical and sub-tropical soils (Brady and Weil, 2002). Phosphorus plays an important role as a structural component of the cell constituents and metabolically active compounds. It is a constituent of sugar phosphate viz. ADP, ATP etc., nucleic acid purine, pyrimidine etc. and various coenzymes. In combination with different organic acids, phosphorus forms esters, phosphatides and phospholipids. As phosphoric ester of Inositol, phosphorus is a major component of phytine. Besides, phosphorus play an important in energy transformation and metabolic process of plants. The deficiency of phosphorus disturb the nitrogen metabolism and also results in an increased accumulation of free reducing sugars, suggesting an involvement of phosphorus in carbohydrate metabolism. Phosphorus is not reduced in plants but remains in its highest oxidised form. Phosphorus in soils almost exclusively occurs as orthophosphate ions. The

total P content is in the range of 0.02 to 0.15%. A large amount of this P is bound with soil organic matter and about 20-80 % of the total P in soils are in the forms of organic fraction. Broadly, P fractions in soils can be grouped into two non-occluded inorganic phosphate and occluded inorganic phosphate. The non-occluded fraction includes soil solution phosphate, adsorbed phosphate and some phosphate minerals. The occluded phosphate fraction is held by Fe and Al minerals often with in a skin of Fe hydroxy compounds.

Phosphorus (P) fraction is an applicable technique to determine the P status of soils and study the chemistry and genesis of soils (Chang and Jackson, 1957; Cross and Schlesinger, 1995). Knowledge of P fraction is important for evaluation its status in soil and understanding soil chemical properties that influence soil fertility and environmental quality. Soil P fraction has been investigated since 1957 and was later applied to soils and sediments to over come the limited information that total P analysis can provide (Zhou et al, 2001).

The relationship between organic and inorganic P forms has been broadly discussed in several studies. For example large fractions of P available to agricultural crops were shown to be maintained due to higher rate of cycling for organic P than for inorganic P (Xavier et al, 2009). The Ca-P, Fe-P, Al-P and organic P fraction are considered to be relatively active depending on the actual properties of the soil (Jalali and Ranjbar 2010). The objective of the study is to know the relation between phosphorus fraction and physico-chemical properties of surface soil of Varanasi region.

MATERIALS AND METHODS:

A number of plot under jetropha were selected from different site of district Varanasi is mainly dominated by Indo-gangetic alluvial soils, alkaline in nature. Soil samples were collected from more than 25 years old jetropha growing soils of Varanasi with the help of a tube auger (stainless steel). The samples were drawn from surface, stored in the labelled polythene bags site wise for conducting selected laboratory analysis.

Determination of various farms of phosphorus in the soil samples:

The various phosphorus fraction such as Saloid bound-P, Al-P, Fe-P, Ca-P, reductant soluble-P, occluded-Al-Fe-P, organic-P, inorganic-P and total phosphorus.

Total phosphorus: It is determined by H2SO4;Se digestion mixture as mentioned in soil analysis (part5) (4^{th}Ed.1988-Houba et al.,1988).

Inorganic phosphorus: Inorganic phosphorus fraction were determined by using the methods given by Chang and Jackson (1957).

Saloids bound phosphate: Saloids bound phosphate were determined using method given by (Agbenin and Tissen 1995).

Aluminium phosphate: Aluminium phosphate is determined by change and jackson methods modified by (Olsen and Sommers 1982).

Iron phosphate: Iron phosphate was determined by method given by Chang and Jackson (1957) as modified by Corey and Peterson (1966).

Calcium phosphate: Determined by modified Chang and Jackson method of P fraction (Olsen and Sommers 1982).

Reductant soluble Fe-P: This forms of phosphate is determined by ascorbic acid method describe by Murphy and Riley (1962).

Occluded Al-Fe-phosphate: Estimation of occluded Al-Fe-P were done by modified Chang and Jackson method of P-fraction (Olsen and Sommers 1982).

Organic phosphorous: Organic phosphate is determined by Bowman-Cole method (Bowman 1976). It was determined by subtracting the amount of inorganic phosphorus from total phosphorus.

Statistical analysis: Data obtained from all the observation were statistically analysed. correlation between various parameters, range, Mean and standard deviation the relationship between relevant soil properties and various phosphorus forms of soils were calculated by using standard statistical methods. The correlation coefficient was determined by using the formula: (Shedecon and Cochoram, 1967)

Result and Discussion: The various phosphorus fraction such as Saloid bound-P, Al-P, Fe- P, Ca-P, reductant soluble-P, occluded-Al-Fe-P, organic-P and total phosphorus is presented in Table-1 and correlation between various physico-chemical properties of surface soils such as pH ,EC, organic carbon and bulk density with soil phosphorus fraction such as saloid bound –P, Al-P, Fe-P ,Ca-P, reductant soluble-P, occluded Al-Fe-P ,and organic-phosphorus in jetropha growing soils of Varanasi district are completed in Table-2.

Saloid bound-P

The present study revealed that the saloid bound-P ranging between 23.43 to 44.62 ppm. These results where well with in the ranged described by Sood and Bhardwaj (1992). The mean value of saloid bound-p was 32.37 ppm. the highest value (44.62 ppm) of saloid bound-P was obtained in Harhua (S_{52}). Whereas lowest (24.43 ppm) in 39 GTC (S_{21}). The highest amount of saloid bound-P in surface soil could be due to the slow transformation of soluble forms of P added into relatively less soluble forms with progress of times. Saloid bound-P shows negative non-significant correlation with pH (r=-0.17), EC (r=-0.11), O.C. (r=-0.14) and positive non-significant correlation with bulk density (r=0.10). Similar results were found by Niranjana *et al.* (1997) in surface soils of Karnataka.

Aluminium-phosphate

The Aluminium-P in jetropha growing surface soil ranged from 10.75 to 20.02ppm with an average value of 15.17 ppm.The less amount may have resulted from more weathered soil condition (Patel *et al.* 1992). The highest value (20.02 ppm) was obtained in Sarnath (s_{47}) were as lowest value (10.75 ppm) in Harhua (S_{52}). Similar observation have been reported by Niranjana *et al.* (1997) in surface soil of Karnataka. Al-P showed positive non-significant correlation with pH (r=0.16), EC (r=0.18) and negative non-significant correlation organic carbon (r=- 0.12), bulk density (r=-0.21). It also showed negative significant correlation with Saloid bound-P ($r=-0.65^{**}$). Similar positive non-significant correlation with pH and Al-P was obtained by Chand and Tomar (1993) in some soils of Hariyana.

Iron-P

The result depicted in table 1 indicated that the Fe-P value in jeteropha growing Soil varied between 6.96 to 13.4 ppm with average value 10.56 ppm. Sarnath (S_{47}) recorded highest value (13.4 ppm) and Harhua (S_{52}) was recorded lowest value (6.96 ppm) of Fe-P. These results were in concomite with the observation of Patel *et al.* (1992) and Sharma (2007) in soils of Punjab. The Fe-P in these soils might be attributed to presence of sesquioxides. Fe-P showed positive non-significant correlation with pH (r=0.11). It showed positive non-significant correlation with EC (r=0.18), and negative non-significant correlation with organic carbon (r=-0.19). Fe-P showed negative non-significant correlation with bulk density (r=-0.010). It showed negative significant correlation with Saloid bound-P ($r=-0.55^{**}$).

Calcium-P

The calcium-P of Jetropha growing soil ranged from 80.97 to115.78 ppm with a mean value of 98.41 ppm table 1. Harhua (S_{52}) to recorded highest value (115.78 ppm) and 39 GTC (S_{21}) have lowest value (80.97 ppm).higher amount of Ca-P as compare to other inorganic-P from may be due to more amount of exchangeable Calcium in these soils. Similar results were also obtained by Singh *et al.* (2003) in the soils of Vertisols. Ca-P showed negative non-significant correlation with pH (r=- 0.051), EC (r=-0.020), positive non-significant correlation with organic carbon(r=0.056) and bulk density (r=0.032). It was also showed positive significant correlation with saloid bound-P ($r=0.82^{**}$). Calcium-P shows positive significant correlation with Al-P ($r=0.59^{**}$) and negative significant correlation with Fe-P ($r=-0.56^{**}$). Similar results are recorded by Sarkar *et al.* (2014).

Reductant soluble-P

The present study revealed that the reductant soluble-P is ranging between 10.68 to 27.70 ppm. The lowest value of reductant soluble-P was recorded (10.68 ppm) in 38 GTC (S_{18}) whereas highest value (27.70 ppm) in SARNATH (S_{47}). The average value was 23.27 ppm).The reductant soluble-P in these soil may be due to weathered condition of the soil. These results was in agreement with the Kalivanan *et al.* (2012) in the soils of Karnataka, Tamilnadu, Gujrat and AP. Reductant soluble-P showed negative non-significant correlation with pH (r=-0.008), positive non-significant correlation with EC (r=0.070), negative non-significant correlation with organic carbon (r=- 0.109) and bulk density (r=-0.093). It also show negative significant correlation with Saloid bound-P ($r=-0.43^{*}$) and negative significant correlation with Ca-P ($r=-0.50^{*}$). It also showed positive significant correlation with Al-P ($r=0.69^{**}$) and Fe-P ($r=0.71^{**}$). Similar was also obtained by Ravindra *et al.* (1999).

Table no.1. Fraction of Phosphorus in surface soil.

Place	Sample no.	Salod Boud-P (ppm)	Al-P (ppm)	Fe-P (ppm)	Ca-P (ppm)	Reduct soluble-P (ppm)	Occlud Al-FeP (ppm)	Inorg.. P(ppm)	Total-P (ppm)	OrgnicP (ppm)
DLW	S1	30.82	14.78	10.75	92.28	25.63	14.36	188.62	293.75	105.13
	S_2	33.71	12.36	9.84	93.65	22.75	16.65	188.96	306.85	117.89
	S_3	36.42	11.34	9.25	98.68	20.34	17.76	220.79	364.78	143.94
	S_4	32.35	13.85	9.79	96.43	21.68	16.45	190.55	356.52	165.97
	S_5	28.69	15.62	10.85	90.75	27.68	13.34	186.93	271.78	84.85
	S_6	30.75	14.89	10.25	96.32	27.52	14.68	194.41	361.53	167.12
	S_7	25.62	15.62	11	94.75	27.75	13.75	188.49	345.75	157.62
	S_8	32.65	14.76	10.52	100.62	26.95	14	199.5	370.73	171.23
	S_9	35.72	12	9.79	111.93	11.45	26.75	206.64	376.96	170.32
	S_{10}	36.16	11.68	9.63	115.75	19.93	18.37	211.52	383.84	172.32
38-GTC	S_{11}	26.75	15.75	10.15	98.62	23.75	15.21	190.23	358.75	168.52
	S_{12}	29.62	15	10	99.68	24.62	14.35	193.27	360.26	166.99
	S_{13}	25.75	16.34	10.92	93.75	27.45	16.85	191.04	285.74	94.7
	S_{14}	31.62	14.75	10	101.62	25.35	13.62	196.96	338.64	141.68
	S_{15}	34.52	13.21	9.43	106.74	12.85	19.45	196.2	346.48	150.28
	S_{16}	30.69	14.36	9.65	101.93	14.69	18.67	189.99	336.59	146.6
	S_{17}	26.45	15.75	10.72	94.28	26.75	15.64	189.59	298.79	109.2
	S_{18}	34.38	12.34	8.35	103.64	10.68	25.86	195.25	356.16	160.91
	S_{19}	31.69	13.76	9.42	98.56	15.75	19.15	188.35	299.74	111.41
	S_{20}	27.34	14.48	9.67	92.79	16.85	15.45	176.58	278.94	102.36
39- GTC	S_{21}	24.43	18.2	11.25	80.97	26.52	13.62	175.09	270.75	95.66
	S_{22}	25.75	16.48	11.69	89.75	26.83	15.09	187.56	280.85	93.26

	S_{23}	31.46	16.72	10.45	92.65	25.7	17.75	194.73	292.75	98.02
	S_{24}	30.3	17	10.62	92.4	25.08	17.2	192.6	324.72	131.12
	S_{25}	32.42	16.2	9.92	96.72	24.68	19.35	199.29	298.45	99.16
	S_{26}	29.92	18.15	11.08	94.32	26	18.67	198.14	316.42	118.26
	S_{27}	30.75	17.45	10.79	95.68	25.4	18.98	199.05	297.9	98.85
	S_{28}	25.67	19.02	12.68	93.4	27.35	17.4	195.52	295.78	100.23
	S_{29}	24.97	19.46	13.25	93.08	27.68	17.06	195.5	295.3	99.8
	S_{30}	30.46	16.72	9.96	93.65	24.91	18.25	193.95	306.07	112.12
UPC	S_{31}	38.76	14.68	9.88	101.75	23.95	21.62	210.64	363.45	152.81
	S_{32}	42.69	14.09	9.49	115.68	23.32	26.45	231.72	377.08	145.36
	S_{33}	35.7	15.68	10.25	98.75	24.61	20.4	205.39	301.62	96.23
	S_{34}	27.84	17.45	11.37	92.68	26.49	17.15	192.98	306.78	113.8
	S_{35}	29.7	16.82	11	94.08	26	18.62	162.67	318.91	155.84
	S_{36}	37.68	15.65	10.78	109.76	25.28	21.95	221.1	346.75	125.65
	S_{37}	39.45	14.46	10.43	110.4	24.79	22.7	222.23	358.85	136.62
	S_{38}	36.48	16	10.79	108.75	25.31	21.54	218.87	351.78	132.91
	S_{39}	40.74	15.72	11.28	112.75	25	23.92	229.41	366.7	137.29
	S_{40}	41.69	15.09	11.06	114.95	25.08	24.7	232.57	369.45	136.88
SAR	S_{41}	36.35	12.9	9.78	99.62	22.08	15.67	196.4	366.75	170.35
	S_{42}	33.45	14.21	10.53	94.62	24.34	14.34	191.4	361.82	170.33
	S_{43}	32.35	14.68	10.96	92.75	25.26	13.76	189.76	357.62	167.86
	S_{44}	34.68	13.4	10.25	96.72	24.78	15.25	195.08	365.7	170.62
	S_{45}	28.95	19.75	12.58	90.85	27.62	13.12	192.87	291.75	98.88
	S_{46}	30.86	17.85	11.78	91.72	26.56	13.45	192.22	295.82	103.6
	S_{47}	27.48	20.02	13.4	89.68	27.7	13.08	191.36	290.7	99.34
	S_{48}	27.95	19.79	12.69	90.46	27.25	15.3	193.44	291.56	98.12
	S_{49}	35.4	12.25	9.95	101.35	22.38	22.65	203.98	369.65	165.67
	S_{50}	37.32	11.69	6.98	110.69	10.95	24.75	202.38	374.34	171.96
HAR	S_{51}	35.69	12.08	9.51	102.2	20.68	23.34	203.5	371.75	168.25
	S_{52}	44.62	10.75	6.96	115.78	11.78	26.32	216.21	376.78	160.57
	S_{53}	39.68	11.68	8.75	113.68	18.24	25.71	217.74	375	157.26
	S_{54}	30.4	17.52	11.25	91.06	25.78	13.76	189.77	276.75	86.98
	S_{55}	29.69	15.72	12.67	91	26.95	13.02	189.05	276	86.95
	S_{56}	34.68	13.86	12.08	93.46	25.86	15.34	195.28	277.8	82.57
	S_{57}	32.2	14.68	12.35	92.35	27	14.18	192.76	275	82.24
	S_{58}	30.35	17.7	13.06	91.28	27.58	13.38	193.35	274.76	81.41
	S_{59}	35.44	12.65	9.86	97.68	20.78	19.39	195.8	306.75	110.95
	S_{60}	32.3	13.92	10.59	92.95	12.68	14.34	176.78	295.68	118.9
	Mean	**32.37**	**15.17**	**10.56**	**98.41**	**23.27**	**17.88**	**197.7**	**326.74**	**129.02**

Occluded Al-Fe-P

The occluded Al-Fe-P obtained in jeteropha growing soil varied from 13.02 to 26.75 ppm with the average value 17.88 ppm.The highest value of occluded Al-Fe-P (26.75 ppm) was recorded in DLW campus (S_9) were as lowest value of (13.02 ppm) Harahua (S_{55}). The presence of occluded Al-Fe-P in sulphate soil might be attributed the weathering of the soil. These result were in agreement with Singh *et al.* (2003). Occluded Al-Fe-P showed negative non-significant correlation with pH (r=-0.20), EC (r=-0.1897) and bulk density

(r=-0.089). It also showed positive non-significant correlation with organic carbon(r=0.11). Similar non-significant correlation was observed between pH and organic carbon Mandal *et al*. (2002) in Tarai Zone of west-Bengal. It also showed positive significant correlation with Saloid bound-P (r=0.73**) and negative significant correlation with reductant soluble-P (r=-0.55**).

Total-P

The present study showed that total-P content is ranging between 270.75 to 383.84ppm with average value of 326.74 ppm. DLW campus (S_{10}) recorded highest value of total-P (383.84 ppm and 39 GTC campus (S_{21}) have lowest value (270.75 ppm of total-P. Higher smectite type clay mineral in these soil responsible for more total-P. These result are in conformity with those reported by Lungmuana *et al*. (2012) in red and lateritic zone of west-Bengal. Similar results were also found by Mandal *et al*. (2002) in the soils of Tarai zone of west-Bengal. It showed negative non-significant correlation with pH (r=-0.11), EC (r=-0.118), BD (r=-0.14) and positive non-significant correlation with organic carbon (r=0.15). It also showed positive significant correlation with Saloid bound-P (r=0.66**), Ca-P (r=0.78**) and occluded Al-Fe- P(r=0.57**). Similar relationship with pH was also reported by Mandal *et al*. (2002) in the soils of Tarai-Zone of West-Bengal.

Organic-P

The organic-P status of jeteropha growing soils of Varanasi district is present in table 1.The organic-P content varied in soils under study from 81.41 to 172.32ppm with mean value of 129.02 ppm. The lowest value of organic-P was obtained in Harahua 81.41 ppm (S_{58}) and highest value recorded in DLW campus 172.32 ppm (S_{10}). The higher organic carbon content of jeteropha growing soil was responsible for higher organic-P. These result are in agreement with Lungmuana *et al.* (2012) in red and lateritic zone of west-Bengal. Organic-P showed negative non-significant correlation with pH (r=-0.080), EC (r=-0.012) and bulk density (r=-0.18). It also showed positive non-significant correlation with organic carbon (r=0.22). It also showed positive significant correlation with saloid bound-P (r=0.45**). Similar relationship with pH was found by Mandal *et al.* (2002) in Tarai-Zone of West-Bengal.

Table no. 4.3 correlation between various physico- chemical properties of surface soil and forms of phosphorus

	pH	EC	OC	BD	Saloid Bound -P	Al-P	Fe-P	Ca-P	Red. Soluble -P	Occluded Al-Fe-P	Inorg.-P	Total- P	Org.- P
p^H	1												
EC	0.70**	1											
O C	-0.021	-0.057	1										
BD	0.32	0.29*	-0.35	1									
Saloid bound-P	-0.17	-0.11	-0.14	0.10	1								
Al-P	0.16	0.18	-0.12	-0.21	-0.65**	1							
Fe-P	0.11	0.18	-0.19	-0.010	-0.55**	0.79	1						
Ca-P	-0.051	-0.020	0.056	0.032	0.82**	0.59**	0.56**	1					
Red. Sol- P	-0.008	0.070	-0.109	-0.093	-0.43*	0.69**	0.71**	-0.50*	1				
Occ-p	-0.20	-0.189	0.11	-0.089	0.73**	-0.48	-0.59	-0.81	-0.55**	1			
Inorganic-p	-0.13	-0.046	-0.09	0.0021	0.78**	-0.31	-0.25	-0.80	-010	0.68*	1		
Total-P	-0.11	-0.118	0.15	-0.14	0.66**	-0.62	-0.62	0.78**	-0.40	0.57**	0.59	1	
Organic-P	-0.080	-0.012	0.22	-0.18	0.45*	-0.61	-0.62**	0.58	-0.43*	0.38*	0.27	0.93**	1

*Represent significant at 0.05 % level

** Represent significant at 0.01% level

Conclusions:

In surface soil, it was found that the pH showed negative non-significant correlation between various forms of phosphorus such as saloid bound-P, Ca-P, reducrant soluble-P occluded-Al-P-Fe-P except Al-P and Fe-P fraction. EC showed the negative non-significant correlation with Saloid bound-P, Ca-P, Occluded Al-Fe-P, Total-P and Organic-P & positive non-significant correlation with Al-P, Iron-P and Reductant soluble-P. Surface soil showed negetive non significant correlation between saloid bound-P, Al-P, Fe-P and reductant soluble-P and organic carbon while Ca-P, Occluded Al-Fe-P, Total-P and Organic-P showed positive non-significant correlation with organic carbon. It indicated that the higher content of organic carbon showed strong relation with all phosphorus fraction. Over all results indicated that jetropha trees have positive effect on various forms of phosphorus and organic

carbon content.

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