Studies on Different Forms of Sulphur in Alluvial Soil

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Abstract

The present study was carried out in the Sadar Tehsil of Pratapgarh District of Uttar Pradesh to examine the different forms of sulphur (i.e., total sulphur, organic sulphur, NaH_2PO_4 extractable sulphur, heat soluble sulphur and 0.15% $CaCl_2$ extractable sulphur) in its soil. For this purpose, soil samples at the depth varying between 0 to 120 cm from 10 locations were collected. These locations are Bakulahi (S-1), Benipur (S-2), Chakbantod (S-3), Chaughar Pure anti (S-4), Chaukhad (S-5), Jagdishpur (S-6), Jahanaipur (S-7), Jahargo (S-8), Kaila Kala (S-9) and Khurdaha (S-10). It was observed that the total sulphur content decreases with increasing the soil depth in all the sampling locations. The similar trend was also observed in organic sulphur, Sodium dihydrogen ortho phosphate (NaH_2PO_4) extractable sulphur, heat soluble sulphur and 0.15% $CaCl_2$ extractable sulphur.

Correlation coefficient studies showed that total sulphur has significant and positive correlation with pH, EC, OC, $CaCO_3$ and sand while negative correlation with clay and CEC. Organic sulphur correlated significantly and positively with all parameters, except clay and CEC which showed negative correlation with it. The NaH_2PO_4 extractable sulphur showed significant positive correlation with pH, EC, OC and sand while negative correlation with $CaCO_3$, clay and CEC. Heat soluble sulphur had significant positive correlation with all parameters, except $CaCO_3$ and clay which showed negative correlation with it. The 0.15% $CaCl_2$ extractable sulphur showed positive correlation with pH, EC, OC and sand while negative correlations with $CaCO_3$, clay and CEC.

1. INTRODUCTION

Our country is basically agrarian in nature. Due to increasing population, urbanization and industrialization, the land masses available for agriculture are getting reduces day by day. Hence the pressure on the remaining fertile land is increasing continuously. Soil is a precious resource and its every bit is so essential to life as air and water. Grains, vegetables and fruits come from plants growing in the soil. Each plant has unique nutritional requirements which are being fulfilled from the soil through capillary action with the help of their roots. Nitrogen, Phosphorous, Potassium and Sulphur are used in large quantities by all growing plants.

In India nearly 57 M ha of arable land suffers from various degrees of sulphur deficiency [15]. The availability of sulphur is largely dependent on its fractions [12]. Sulphur is a secondary plant nutrient. It is required by plants and animals as nitrogen, phosphorus and zinc. Because of its volatile nature, large amount of sulphur have become dispersed in the atmosphere. Such atmospheric fraction contributes significantly in the plant growth and nutrition. Sulphur plays an important role in

the formation of chlorophyll and improves the activity of ATP–sulphurylase enzyme. It is associated in the formation of biologically important compounds like thiourea, plant regulators, thiamin, biotin and glutathione. Sulphur also plays a significant role in nitrogen metabolism of plants. In well leached surface soil much of the sulphur is combined with organic matter soluble sulphates in the soil solution or adsorbed in the soil complex [14]. Sulphur is presently considered the fourth most important nutrient after N, P and Zn for Indian agriculture [9].

The present work has been undertaken in soils of one of its agriculturally important district, i.e., Pratapgarh to assess the different forms of sulphur and identify their relationship between the soil properties.

2. MATERIALS AND METHODS

Geographically Pratapgarh falls under subtropical climatic zone of Indo-gangatic alluvial plane of eastern U.P. The district lies between the parallels of 25°34' and 26°11' north latitude and between the meridians of 81°19' and 82°27' east longitude with the altitude of 137 meters by the sea level.

The present study was undertaken with a view to investigate the characteristics of soil with special reference to different forms of sulphur in Sadar tehsil of Pratapgarh district.

The soil samples at depth varying between 0 to 120 cm from 10 locations of Sadar tehsil in Pratapgarh district were collected with the help of post hole auger. The selected locations are Bakulahi (S-1), Benipur (S-2), Chakbantod (S-3), Chaughar Pure anti (S-4), Chaukhad (S-5), Jagdishpur (S-6), Jahanaipur (S-7), Jahargo (S-8), Kaila Kala (S-9) and Khurdaha (S-10). The samples were processed and analysed for various soil properties. The pH and EC were determined as adopted by Jackson [6]. Organic carbon (OC) was determined by wet digestion method as given by Black [2]. Clay, sand, $CaCO_3$ content and CEC were determined by the Bouyoucous hydrometer method as per the procedure outlined by Piper [7].

The different form of sulphur were analysed by using the standard methods. The total sulphur, heat soluble sulphur and 0.15% $CaCl_2$ extracted sulphur were estimated as the methods given by William and Steinberg [18]. Sodium dihydrogen phosphate extractable sulphur was determined as given by Gundy, Mcelroy and Cooper [17]. The organic sulphur was measured as suggested by Black [2].

3. RESULTS AND DISCUSSION

It is found by the study that some of the parameters were considerably changed at some sampling points. The analysis report is given in Table-1 and 2 (Annexure- 1 and 2). The correlation coefficients (calculated by using Pearson's correlation coefficient formula) between the various parameters are shown in Table-3 (Annexure - 3).

The maximum pH (8.5) was found in Jagdishpur at the depth of 0-30 cm. whereas the minimum pH (6.4) was found in Chaughar Pure anti at the depth of 90-120 cm.

The maximum EC (1.59 dSm^{-1}) was recorded in Kaila Kala at the depth of 0-30 cm. whereas the minimum EC (0.70 dSm^{-1}) was found in Chaughar Pure anti at the depth of 0-30 cm. as well as 90-120 cm. The same minimum value is also found in Chaukhad at the depth of 90-120 cm.

The maximum OC (6.5 gkg^{-1}) was found in Kaila Kala and Khurdaha at the depth of 0-30 cm. whereas the minimum OC (0.2 gkg^{-1}) was found in Chakbantod at the depth of 90-120 cm.

The maximum $CaCO_3$ (2.43%) was found in Benipur at the depth of 60-90 cm. whereas the minimum $CaCO_3$ (0.63%) was found in Jahargo at the depth of 60-90 cm.

The maximum sand (55.91%) was found in Jahargo at the depth of 0-30 cm. whereas the

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minimum sand (21.87%) was found in Chaukhad at the depth of 60-90 cm.

The maximum clay (37.51%) was found in Chaukhad at the depth of 90-120 cm. whereas the minimum clay (13.67%) was found in Khurdaha at the depth of 90-120 cm.

The maximum CEC (13.7 cmol (+) kg^{-1}) was found in Chakbantod at the depth of 90-120 cm. whereas the minimum CEC (8.2 cmol (+) kg^{-1}) was found in Khurdaha at the depth of 0-30 cm.

The texture class of Bakulahi and Kaila Kala was loam, Benipur, Jahargo and Khurdaha was sandy loam, Chakbantod, Chaughar Pure anti, Chaukhad and Jahanaipur was clay loam, and Jagdishpur was sandy clay loam.

The maximum value of total sulphur (50.37 mg kg^{-1}), NaH_2PO_4 extractable sulphur (6.23 mg kg^{-1}), heat soluble sulphur (5.90 mg kg^{-1}) and $CaCl_2$ extractable sulphur (4.95 mg kg^{-1}) was found in Jagdishpur at the depth of 0-30 cm. whereas the minimum value of total sulphur (10.06 mg kg^{-1}), NaH_2PO_4 extractable sulphur (1.10 mg kg^{-1}), heat soluble sulphur (1.30 mg kg^{-1}) and $CaCl_2$ extractable sulphur (1.12 mg kg^{-1}) was found in Kaila Kala at the depth of 90-120 cm.

The maximum organic sulphur (37.00 mg kg^{-1}) was found in Khurdaha at the depth of 0-30 cm. whereas the minimum organic sulphur (5.97 mg kg^{-1}) was found in Benipur at the depth of 90-120 cm.

The soil of present study showed the better status of NaH_2PO_4 extractable sulphur as compared to $CaCl_2$ extractable sulphur in all the sampling stations as well as at all the similar depths. It might be due to the better extraction capacity of NaH_2PO_4 which extract readily soluble sulphates, adsorbed sulphates and organic sulphur whereas $CaCl_2$ extracts only the readily soluble sulphates [3].

The Correlation coefficient studies showed that the total sulphur has positive correlation with pH, EC, OC, $CaCO_3$, sand, organic sulphur, NaH_2PO_4 extractable sulphur, heat soluble sulphur and $CaCl_2$ extractable sulphur while negative correlation with clay and CEC. Organic sulphur also showed the similar trend of correlation. The NaH_2PO_4 extractable sulphur showed the positive correlation with pH, EC, OC, sand, total sulphur, organic sulphur, heat soluble sulphur and $CaCl_2$ extractable sulphur while negative correlation with $CaCO_3$, clay and CEC. $CaCl_2$ extractable sulphur also showed the similar trend of correlation. Heat soluble sulphur had significant positive correlation with all parameters, except $CaCO_3$ and clay which shows negative correlation with it.

4. CONCLUSION

The knowledge about various forms of sulphur in soil and their availability controlled by different soil properties will be helpful for its management to optimize crop yields in the Sadar Tehsil of Pratapgarh. The study also gives an idea regarding the depth distribution of different forms of sulphur, which showed that generally the values of all the forms decreases with soil depth.

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(Annexure-1)

Table-1: Physical and Chemical Properties of Soils

Location	**Depth (cm)**	**pH**	**EC** dSm^{-1}	**OC** gkg^{-1}	**$CaCO_3$** **%**	**Sand %**	**Clay %**	**Textural Class**	**CEC** **[cmol (+) kg^{-1}]**
S-1 Bakulahi	0-30	7.2	0.92	4.2	1.82	38.51	20.41	Loam	12.6
	30-60	7	0.96	2.8	1.84	33.2	22.11	Loam	12.8
	60-90	7.3	0.89	2.6	2.02	31.52	23.15	Loam	11.5
	90-120	7.1	0.87	2.3	2.17	32.8	24	Loam	12.4
S-2 Benipur	0-30	7	0.82	3.6	2.34	50.51	20.23	Sandy loam	8.7
	30-60	6.8	0.83	1.8	2.37	49.12	22.53	Sandy loam	8.9
	60-90	6.7	0.81	1.6	2.43	47.81	24.31	Sandy loam	10.4
	90-120	6.5	0.84	1.3	2.38	47	24.31	Sandy loam	9.5
S-3 Chakbantod	0-30	7.3	0.73	2.5	2	26.3	30.65	Clay loam	12.8
	30-60	7.2	0.78	0.7	1.8	25.73	31.78	Clay loam	12.5
	60-90	7.1	0.81	0.4	1.75	23.3	31.58	Clay loam	13.2
	90-120	7.1	0.8	0.2	1.9	23	33.24	Clay loam	13.7
S-4 Chaughar Pure anti	0-30	7.1	0.7	3.4	1.45	28.41	33.82	Clay loam	10.8
	30-60	7	0.82	2.5	1.25	28	36.21	Clay loam	11
	60-90	6.6	0.76	1.9	1.3	29.18	37.12	Clay loam	10.2
	90-120	6.4	0.7	2	1.24	27.91	37.2	Clay loam	9.8
S-5 Chaukhad	0-30	7.8	0.8	4.8	1.71	25.93	31.65	Clay loam	10.5
	30-60	7.6	0.84	2.9	1.59	23.2	35.5	Clay loam	10.4
	60-90	7.5	0.71	2.6	1.54	21.87	36.72	Clay loam	9.9
	90-120	7.3	0.7	1.9	1.52	22.25	37.51	Clay loam	9.7
S-6 Jagdishpur	0-30	8.5	1.02	3.2	1.16	54.8	28.25	Sandy clay loam	11.7
	30-60	7.6	0.96	2.1	1.35	52.25	26.5	Sandy clay loam	11.8
	60-90	7.8	1.1	1.6	1.15	51.73	27	Sandy clay loam	12
	90-120	8	1.45	1.1	0.92	50.04	27.34	Sandy clay loam	11
S-7 Jahanaipur	0-30	7.8	0.76	3.5	1.34	38.5	29.15	Clay loam	13
	30-60	7.3	0.73	3.2	1.28	35.83	29	Clay loam	12.9
	60-90	7.5	0.72	3	1.05	34.02	28.43	Clay loam	12.5
	90-120	7.2	0.71	2.2	1.48	33.52	30.12	Clay loam	12.2
S-8 Jahargo	0-30	7.6	0.8	3.8	0.89	55.91	18.6	Sandy loam	9.7
	30-60	7.4	0.78	2	0.9	54.32	18.41	Sandy loam	9.9
	60-90	7.2	0.76	2.3	0.63	51.78	17.78	Sandy loam	10.4
	90-120	7.3	0.73	1.9	0.75	50.45	16.24	Sandy loam	10.2
S-9 Kaila Kala	0-30	7	1.59	6.5	1.63	45.82	22.56	Loam	11.2
	30-60	6.7	1.2	3.2	1.28	44.12	21.43	Loam	11.8
	60-90	6.8	0.98	2.8	1.35	42.62	19.04	Loam	12.1
	90-120	6.5	0.96	1.7	1.2	41.26	21.43	Loam	12.5
S-10 Khurdaha	0-30	7.3	0.79	6.5	1.06	52.6	15.91	Sandy loam	8.2
	30-60	7.2	0.78	3.9	0.98	48.45	15.3	Sandy loam	8.5
	60-90	7.1	0.76	2.2	1.31	46.75	14.42	Sandy loam	9.8
	90-120	6.7	0.75	3.5	1.25	45.03	13.67	Sandy loam	10

(Annexure-2)

Table-2: Distribution of various forms of Sulphur (mg kg^{-1}) in the alluvial soil of Sadar tehsil of Pratapgarh.

Location	Depth (cm)	Total S	Organic S	NaH_2PO_4 Extractable S	Heat Soluble S	$CaCl_2$ Extractable S
S-1 Bakulahi	0-30	45.23	29.57	4.12	4.53	3.9
	30-60	42.37	25.7	3.86	4.15	3.65
	60-90	30.12	20.64	2.9	3.2	2.67
	90-120	13.58	6.69	1.82	1.89	1.43
S-2 Benipur	0-30	42.18	27.41	3.84	4	3.25
	30-60	37.52	23.52	2.9	2.98	2.69
	60-90	28.93	19.35	2.21	2.37	2.12
	90-120	12.45	5.97	1.63	1.72	1.23
S-3 Chakbantod	0-30	44.63	28.58	4.02	4.12	3.65
	30-60	40.81	26.73	3.41	3.5	2.9
	60-90	31.5	22.3	2.98	3.42	2.7
	90-120	14.24	6.83	1.88	1.95	1.62
S-4 Chaughar Pure anti	0-30	40.92	29.5	5.86	4.8	4.32
	30-60	29.68	19.56	2.89	2.35	2.67
	60-90	22.19	14.8	4.91	3.72	2.2
	90-120	10.67	11.33	1.18	1.56	1.75
S-5 Chaukhad	0-30	46.5	30.12	3.81	4.1	3.52
	30-60	38	23	3.02	3.63	2.97
	60-90	27.32	17.8	2.58	2	2.49
	90-120	13.15	6.87	1.56	1.73	1.34
S-6 Jagdishpur	0-30	50.37	36.5	6.23	5.9	4.95
	30-60	38.85	28.47	5.27	4.82	4.2
	60-90	30.61	14.81	3.85	3.98	3.82
	90-120	14.12	8.76	2.18	2.08	1.76
S-7 Jahanaipur	0-30	42.9	32.1	4.62	3.98	3.75
	30-60	28.35	14.58	3.8	3.87	3.64
	60-90	20.89	14.02	3.41	3.71	2.18
	90-120	11.6	8.23	2.17	1.7	1.42
S-8 Jahargo	0-30	49.21	36.1	6	5.8	4.85
	30-60	37.43	22.9	4.78	3.9	3
	60-90	29.76	15.12	3.8	3.23	2.81
	90-120	14.43	7.15	1.84	1.96	1.31
S-9 Kaila Kala	0-30	41.87	31.15	4.6	3.9	3.76
	30-60	30.22	22.17	3	2.91	2.75
	60-90	19.78	11.75	2.73	1.89	1.4
	90-120	10.06	11.1	1.1	1.3	1.12
S-10 Khurdaha	0-30	44.71	37	6.05	4.21	4.06
	30-60	33.18	27.12	5.16	3.67	3.8
	60-90	22.42	17.75	3.72	2.4	2.63
	90-120	11.72	12	1.35	1.54	1.6

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(Annexure-3)

Table-3: Correlation coefficient between different forms of sulphur and various physical and chemical properties of soils

Parameter	pH	EC	OC	$CaCO_3$	Sand	Clay	CEC	Tot. S	Org. S	NaH_2PO_4 Extr. S	Heat Sol. S	$CaCl_2$ Extr. S
pH	1											
EC	0.143	1										
OC	0.149	0.201	1									
$CaCO_3$	-0.32	-0.041	-0.154	1								
Sand	0.133	0.338	0.23	-0.314	1							
Clay	0.125	-0.171	-0.316	0.182	-0.765	1						
CEC	0.146	0.173	-0.289	0.1	-0.376	0.276	1					
Total S	0.448	0.096	0.51	0.082	0.162	-0.069	-0.031	1				
Organic S	0.377	0.103	0.603	0.008	0.202	-0.127	-0.107	0.951	1			
NaH_2PO_4 Extr. S	0.47	0.06	0.527	-0.268	0.33	-0.142	-0.117	0.811	0.824	1		
Heat Sol. S	0.542	0.083	0.446	-0.117	0.239	-0.046	0.045	0.888	0.846	0.913	1	
$CaCl_2$ Extr. S	0.523	0.119	0.53	-0.129	0.25	-0.076	-0.015	0.911	0.897	0.897	0.937	1

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