*Agropedology, 2001, **12**, 82-85*

Different forms of sulphur in relation to soil properties in some Alfisols and Inceptisols of Birbhum district of West Bengal

P. K. Bandyopadhyay[1] and G. N. Chattopadhyay[2]

[1] Department of Agricultural Chemistry and Soil Science, Bidhan Chandra Krishi Viswavidyalaya, Mohanpur, West Bengal, 741252

[2]. Institute of Agriculture, Visva-Bharati, Sriniketan, West Bengal, 731236

The status of different forms of S and their inter-relationship with some important soil characteristics decide the sulphur supplying power of soil by influencing its release and dynamics in soil (Singh *et al.* 1999). The present work was undertaken to study different forms of S in Alfisols and Inceptisols of Birbhum district of West Bengal containing highly reactive insoluble compounds of Fe and Al to predict their relationship with various soil properties.

Eighteen unlimed surface soil samples (0-0.20 m) collected from different agricultural farms, belong to the orders of Alfisols and Inceptisols (Soil Survey Staff 1992). Soil samples were analysed for some important soil properties following standard methods. Different forms of S were estimated following the procedures described by Dolui and Nayek (1981). The soils were mainly sandy loam in texture (clay - 20.6 to 31.2%) with varied organic carbon content (2.6 to 5.7 g/kg). The pH of the soils was in the acidic range (5.0 to 6.2). The CEC of the soils varied from 8.4 to 15.9 cmol (p+)/kg with 3.6 to 54.9% Al- saturation and 14.6 to 50.0% Ca- saturation. The hydrous Fe and Al oxide was present in the range of 2.8 to 6.5 per cent.

Total S in these soils ranged from 46 to 110 mg/kg with a mean value of 77.3 mg/kg (Table 1) and these lower values might be due to granite and laterite parent material and ochric epipedon with low organic carbon content. The total S showed a significant positive correlation with organic carbon (r = 0.54*), clay (r = 0.58*) and silt (r = 0.69**) and a significant and negative correlation with sand (r = –.74**). Silt alone accounted for 48 per cent variation in total S content, which is evident from the results of stepwise multiple regression analysis (Table 2). Inclusion of organic carbon and clay as other variables improved the prediction value to 67 per cent. However, soil properties jointly contributed 82 per cent variation in total S. Total S showed significant and positive correlation with non-sulphate S (R = 0.96**), sulphate S (r = 0.66**) and organic S (r = 0.54*) indicating the existence of dynamic equilibrium among different forms of S.

The organic S varied from 6.2 to 26.8 mg/kg with a mean value of 12.8 mg/kg, accounted for only 16.5 per cent of total S (Table 1). A significant negative correlation was found between organic S and pH (r = –0.57*) and this may be attributed to the fact that acidity favours the accumulation and availability of this form in these soils (Kher and Singh 1993). Organic S showed a significant and positive correlation with organic carbon (r = 0.62**) and silt (r =0.54*). In multiple regression studies, organic carbon and free oxides of Fe and Al together accounted 54 per cent variation (Table 2). These two factors along with pH and clay content accounted 69 per cent variation and soil properties jointly contribute 74 per cent variation in organic S content. Organic S had a significant and positive correlation with total S, non-sulphate S and sulphate S (r = 0.54*; 0.49* and 0.60**). Since S is an integral constituent of soil organic matter, such relationships are to be expected.

The sulphate S at different locations varied from 4.3 to 11.2 mg/kg with a mean value of 5.9 mg/kg contributing 7.8 per cent of total S (Table 1). Considering the critical limit of 10 mg/kg for sulphate S in soils, all soils are deficient in available sulphur content and thus may limit crop productivity. Sulphate S showed significant and positive correlations with organic carbon (r = 0.55*) and silt (R = 0.47*). Soil properties jointly contributed 62 per cent variation in sulphate S content (Table 2). Exclusion of pH and oxides of Fe and Al from these properties decreased the predictability by 10 per cent. Again, exclusion of silt and sand decreased the predictability further by 10 per cent each. Sulphate S showed a significant and positive correlation with total S (r = 0.66**), organic S (r =0.60**) and non-sulphate S (r =0.54*). This reflects that transformation and availability of sulphur in soils is dependent on its various forms.

Non-sulphate S content in the soils ranged from 30.3 to 91.9 mg/kg with a mean value of 58.5 mg/kg accounted for 75.6 per cent of total S (Table 1), indicating the presence of highly reactive insoluble compounds of Fe and Al as well as low content of organic matter in these soils (Misra *et al.* 1990). Non-sulphate S showed significant and positive

Table 1. Sulphur contents (mg/kg) of soils

Location	Great groups	Total S	Water soluble S	Sulphate S	Non-sulphate S	Organic S
Khayrasole	Ustochrepts	60-95 (73.3)*	1.8-3.3 (3.8)** (2.8)	5.0-8.1 (9.1) (6.6)	41.2-79.2 (74.2) (54.4))	10.7-14.0 (16.7 (12.2)
Purandarpur	Ochraqualfs	75-98 (84.3)	1.7-3.4 (2.7) (2.3)	4.7-6.2 (6.5) (5.5)	56.8-75.5 (79.6) (67.1)	6.2-16.2 (13.8) (11.6)
Md. Bazar	Ochraqualfs	46-93 (73.6)	1.8-4.8 (3.9) (2.9)	5.0-11.2 (9.9) (7.3)	34.7-66.7 (72.5) (53.5)	6.2-17.5 (17.5) (12.9)
Suri	Ochraqualfs	50-110 (80.0)	1.8-8.0 (5.2) (4.2)	4.3-6.9 (7.0) (5.6)	35.6-91.9 (78.4) (62.7)	7.5-15.0 (14.6) (11.7)
Dubrajpur	Haplaquepts	61-106 (86.3)	1.4-10.6 (5.7) (4.9)	4.7-6.9 (6.6) (5.7)	48.5-68.6 (73.1) (63.1)	7.7-26.8 (20.2) (17.5)
Sainthia	Haplaquepts	52-84 (66.6)	2.0-4.1 (4.9) (3.3)	4.7-5.6 (7.7) (5.1)	30.3-68.3 (75.7) (50.4)	6.5-16.5 (5.2) (11.0)

* and** figures in parentheses indicate mean values and percentage of total sulphur, respectively

correlations with organic carbon (r =0.46*), clay (r = 0.59**), silt (r = 0.61**) and free oxides of Fe and Al (r = 0.62**) but a significant negative correlation with sand (r = -0.71**) suggesting less organic carbon accumulation and high leaching (Kher and Singh 1993). From multiple regression studies (Table 2), clay and silt content accounted 51 per cent variation, however, soil properties jointly contributed largely to the extent of 79 per cent for non-sulphate S variation. Non-sulphate S had exerted a significant positive correlation with total S (r = 0.96**), organic S (r = 0.49*) and sulphate S (r = 0.54*) and a higher value (0.96**) of correlation between total S and non-sulphate S indicated that total S content behaved like the content of non-sulphate S.

Table 2. Effect of soil characteristics on predictability of different forms of sulphur

Forms of S	Regression equation	R^2
Total S		
	(i) $32.42 + 2.66 X_4$**	0.48**
	(ii) $21.56 + 0.95 X_3 + 2.10 X_4$**	0.58**
	(iii) $2.07 + 62.10 X_2 + 0.97 X_3$* + $1.16 X_4$*	0.67**
	(iv) $-121268.79 + 67.05 X_2$* + $1213.81 X_3 + 1214.44 X_4 + 12.57 X_5$	0.80**
	(v) $-137832.69 + 13.25 X_1 + 93.70 X_2$* + $1379.03 X_3 + 1378.76 X_4 + 1377.34 X_5 + 0.414 X_6$	0.82**
Organic S		
	(i) $4.33 + 39.14 X_2$** $-2.07 X_6$*	0.54**
	(ii) $44.55 - 6.12 X_1 + 26.04 X_2$* $- 2.42 X_6$*	0.63**
	(iii) $45.76 - 6.68 X_1 + 23.67 X_2$* $+ 0.18 X_3 + 2.67 X_6$**	0.69**
	(iv) $-5500.82 - 5.98 X_1 + 23.33 X_2$* $+ 55.59 X_3 + 55.56 X_4 + 55.39 X_5 - 2.55 X_6$	0.74**
Sulphate S		
	(i) $2.04 + 8.96 X_2$*	0.30**
	(ii) $2.52 + 9.25 X_2$* $- 0.03 X_3$	0.31**
	(iii) $14.61 + 7.09 X_2 - 0.18 X_3 - 0.12 X5$	0.42**
	(iv) $11822 + 6.61 X_2 - 118.28 X_3 - 118.05 X_4 - 118.19 X_5$	0.52**
	(v) $15729 + 0.08 X_1 + 8.21 X_2 - 157.34 X_3 - 157.11 X_4 - 157.26 X_5 - 0.54 X_6$	0.62**
Non-sulphate S		
	(i) $23.82 + 2.06 X_4$**	0.37**
	(ii) $12.63 + 0.98 X_3 + 1.48 X_4$*	0.51**
	(iii) $-105304.18 + 31.41 X_2 + 1053.97 X_3 + 1054.52 X_4 + 1053.02 X_5$	0.58**
	(iv) $-148060.89 + 19.15 X_1 + 62.16 X_2 + 1480.84 X_3$* $+ 1480.43 X_4$* $+ 1479.15 X_5$* $+ 3.51 X_6$*	0.79**
Water soluble S		
	(i) $32.79 - 4.19 X_1$** $- 1.60 X_6$**	0.57**
	(ii) $32.05 - 4.24 X_1$** $+ 0.07 X_3 - 1.70 X_6$**	0.61**
	(iii) $-19228.11 - 3.96 X_1$** $+ 192.68 X_3 + 192.53 X_4 + 192.57 X_5 - 1.41 X_6$**	0.71**
	(iv) $-20374.22 - 3.19 X_1 + 4.41 X_2 + 204.08 X_3 + 203.93 X_4 + 203.97 X_5 - 1.42 X_6$**	0.73**

X_1, X_2, X_3, X_4, X_5 and X_6 denote pH, organic carbon, clay, silt, sand and oxides of Fe and Al content, respectively

Water soluble S varied from 1.4 to 10.6 mg/kg with a mean value of 3.4 mg/kg and this fraction contributed 4.3 per cent of total S (Table 1). The lower values of water soluble S and sulphate S in the present study may be attributed to high rainfall in this lateritic tract and sandy loam texture (Dolui and Nayek 1981). The water soluble S showed a significant positive correlation with organic carbon (r = 0.58*) and a significant negative correlation with free oxides of Fe and Al (r = -0.48*). The pH along with clay and oxides of Fe and Al could predict 61 per cent of variation in water soluble S (Table 2). The predictability was found to increase to 73 per cent variation by the joint action of soil properties. However, a significant negative regression coefficients of oxides of Fe and Al indicated the low availability of sulphur in the presence of hydrous Fe and Al oxides (Singh *et al.* 1999). The significant positive correlation among water soluble S and organic S (r = 0.69**) indicates the existence of some organically bound sulphate in watersoluble form (Williams and Steinbergs 1959).

Perusal of the data indicated that the abundance of various forms of sulphur in these low base saturated soils was in the order of total S > non-sulphate S > organic S > sulphate S > water soluble S and their availability was influenced by various soil properties. The results indicated that different forms of sulphur in these soils follow each other and are inter-related within them.

References

Dolui, A. K., and Nayek, A. K. (1981). Distribution of different forms of sulphur in some red and lateritic soil profiles of West Bengal. *Indian Agriculturist* **25,** 185-189.

Kher, D., and Singh, N. (1993). Different forms of sulphur in mustard growing soils of north Kashmir. *Journal of the Indian Society of Soil Science* **41,** 160-165.

Misra, U. K., Das, C. P., and Mitra, G. N. (1990). Forms of sulphur in some soils of Orissa in relation to relevant soil properties. *Journal of the Indian Society of Soil Science* **38,** 61-69.

Singh, S. P., Ram, J., and Singh, N, (1999). Sulphur distribution in some soil series of Nagaland. *Agropedology* **9,** 101-104.

Soil Survey Staff (1992). "Soil of West Bengal for Optimising Land use", NBSS Publication 27 (Soils of India series), National Bureau of Soil Survey & Land Use Planning, Nagpur.

Williams, C. H., and Steinbergs, A. (1959). Soil sulphur fractions as chemical indices of available sulphur in some Australian soils, *Australian Journal of Agricultural Research* **10,** 342-352.

Recived : April, 2000; Accepted : July, 2002