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Short Communication

STATUS OF SULPHUR AND ZINC IN SOILS OF LALITPUR DISTRICT OF BUNDELKHAND REGION, UTTAR PRADESH

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Inventory of available S and Zn status of the soil helps in demarcating areas where application of particular nutrient is needed for profitable crop production. The soil must supply S and Zn for desired growth of plants and synthesis of human food. The continuous use of S and Zn free high analysis N and P fertilizers in the intensive cropping system with the diminishing use of organic manures has resulted in the depletion of S and Zn from the soil reserves. The improper nutrient management has led to emergence of sulphur and zinc deficiencies in the soils. The deficiencies of S and Zn, which were sparse and sporadic initially, are now widespread. Since, no systematic information is yet available on status of sulphur and zinc in soils of Lalitpur district of Uttar Pradesh, the present study was conducted to assess the status of S and Zn in soils of Lalitpur district and find out the relationship of various soil properties with available S and Zn. Two hundred surface soil (0-23 cm) samples were collected from different locations of Lalitpur district. These soil samples were analyzed for pH, EC, organic carbon, silt + clay and $CaCO_3$ by adopting standard procedures (Jackson 1973). Total sulphur and zinc were extracted with perchloric acid. Available S was extracted from soil with 0.15% C_aCI_2 solution and in the extract S was determined by turbidimetric method (Chesnin and Yien, 1951). Available Zn in these soils was extracted by DTPA as per method described by Lindsay and Norvell (1978) and Zn in the extract was determined on Atomic Absorption Spectrophotometer.

Some of the important physicochemical properties of the soils of Lalitpur district are presented in Table 1. The soils of Lalitpur district were alkaline in reaction, the variation in pH being from 7.0 to 8.4. The EC values of these soils were found to be within safe limit (0.18 to 0.90 d Sm^{-1}). Organic carbon content in the soils was low to medium, ranging from 0.8 to 7.2 g kg^{-1} with a mean value of 4.7 g kg^{-1}. The amount of C_aCO_3 also varied widely (5 to 35 g kg^{-1}). The silt + clay content varied from 13.0 to 61.5% with a mean value of 30.0 per cent. The total sulphur content in Lalitpur soils ranged from 56.0 to 159 mg kg^{-1} with a mean value of 97.8 mg kg^{-1}. The lower values of total sulphur in these soils might be associated with lower amount of organic carbon. Ali *et al.* (2014) reported similar result in wheat growing soils of Agra district, Uttar Pradesh. Total sulphur content was positively and significantly correlated with organic carbon and negatively with soil pH. The significant positive correlation of total S with organic carbon has also been reported by Das *et al.* (2012). The SO_4–S (extracted by 0.15% C_aCI_2 solution) is used as an index of sulphur availability in many soils, since the variation in this form causes variation in yield and uptake of S in crops. The amount of SO_4-S in Lalitpur soils ranged between 5.2 and 24.0 mg kg^{-1}. This variation in SO_4-S may be attributed to the differences in soil properties, crop management practices and organic matter content. Chandel *et al.* (2012) reported similar results in Agra soils. It is well known that plant roots absorb S as SO_4-S, from the soil solution. Taking 10 mg kg^{-1} SO_4-S as the critical limit, about 45% samples were found to be deficient in SO_4-S. Ali *et al.* (2014) also reported similar results in wheat growing soils of Agra district of Uttar Pradesh. The SO_4-S was positively and significantly correlated with organic carbon but negatively with pH. The significant positive correlation of available S with organic carbon suggests that S supplying power of these soils is largely dependent upon organic matter. These results are in accordance with those of Kaur and Jalali (2008) and Ali *et al.* (2014).

Table: 1: Physico – chemical characteristics and status of S and Zn in soils of Lalitpur district

Characteristics	Range	Mean	Remark
Physico –chemical			
pH	7.0-8.4		
EC (dsm^{-1})	0.18-0.90	0.45	
Org. C (g kg^{-1})	0.8-7.2	4.7	
$CaCO_3$ (g kg^{-1})	5.0-35.0	12.6	
Silt + Clay (%)	13.01-61.54	30.0	
Sulphur			
Total S (mg kg^{-1})	56.0 – 159.0	97.8	45%
Avail. S (mg kg^{-1})	5.2 – 24.0	14.0	
Zinc			
Total Zn (mg kg^{-1})	4.8 – 25.0	10.7	50%
Avail. Zn (mg kg^{-1})	0.25 – 3.53	0.97	

Electrical conductivity correlated positively and significantly with sulphate sulphur. It indicates that with increase in EC, the concentration of SO_4 – S increases, which is in conformity with the results of Gowrishankar and Shukla (1999). Sulphate S did not exhibit any significant correlation with other soil properties. These results are in accordance with those of Jat and Yadav (2006) and Upadhyay (2012). The available S was correlated positively and significantly with silt + clay (Upadhyay 2012). Total zinc content in soils of Lalitpur ranged from 4.8 to 25 mg kg^{-1} with an average value of 10.7 mg kg^{-1}. Total zinc had significant and positive correlation with organic carbon (Table 2).

Table 2: Correlation matrix between soil properties and nutrients

Soil Properties	Sulphur		Zinc	
	Total	Available	Total	Available
pH	-0.16	-0.61**	-0.16	-0.77**
EC	0.17	0.24	0.07	0.10
Org. carbon	0.42**	0.49**	0.54**	0.60**
$CaCO_3$	0.09	0.15	-0.41**	-0.74**
Silt + Clay	0.18	0.45**	0.41**	0.59**

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

Total zinc did not show any significant relationship with pH, EC, C_aCO_3 and silt + clay content. The content of available Zn in these soils varied from 0.25 to 3.53 mg kg^{-1} (Table 1). Using 0.6 ppm DTPA- extractable as deficient, 56% samples in the present investigation are classified as deficient. Similar results were reported by Yadav and Meena (2009) and Singh (2010). Soil pH showed significant negative relationship with DTPA-Zn. Association with EC and available Zn was not observed in our study probably due to a narrow range of EC of the soils. Calcium carbonate exhibited significant negative relation with available Zn status as reported by Yadav and Meena (2009) and Upadhyay (2012). Organic carbon content of these soils was posively correlated with the DTPA - extractable quantities of Zn under these soils. The availability of Zn increased with the increase in organic matter because organic matter acts as chelating reagent Upadhyay (2012) reported that organic carbon showed positive relationship with available Zn. These results suggest that higher organic carbon content in soils leads to protection of crops from zinc deficiency. The silt + clay content showed significant relationship with available Zn as reported by Yadav and Meena (2009).

It is apparent from the study that the status of available S and Zn are deficient in Lalitpur soils. Organic carbon and silt + clay are the soil property that mostly increases the availability of S and Zn. On the other hand, availability of these elements was reduced with increase in C_aCO_3 and soil pH.

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