Agropedology 2009, 19 (2), 112-116

Distribution of micronutrient cations in soils of Patloi Nala micro-watershed of Puruliya district, West Bengal

SOURAV GHOSH, DIPAK SARKAR AND A. K. SAHOO

National Bureau of Soil Survey and Land Use Planning, Regional Centre, Block-DK, Sector-II, Salt Lake City, Kolkata- 700 091, India

Abstract : Status of DTPA-extractable micronutrient cations in relation to some important physical and chemical properties of typical soils (series-wise) was studied in Patloi Nala micro-watershed of Puruliya district, West Bengal. The data indicated that surface soil possessed more acidity than the under lying ones. The DTPA-extractable Fe and Mn were relatively high, whereas DTPA-Cu was above the critical level and Zn was deficient and their concentration decreased with depth. There was significant negative correlation (-0.466 to –0.670) between soil pH and DTPA-extractable micronutrients (except Cu).

Additional key words: *Soil acidity, GIS mapping, zinc deficiency*

Introduction

The status and distribution of micronutrients are very important as they play vital roles in plant metabolism. The roots of many crops go beyond the surface layer and they draw part of their micronutrient requirement from sub-surface and sub-soil (Vijay Kumar *et al.* 1996; Kumar *et al.* 1996; Sarkar *et al.* 2000). Information regarding vertical distribution of micronutrients and their interrelationship among themselves and with other relevant soil properties of this area is virtually lacking and hence the present investigation was carried out.

Materials and Methods

The representative soil samples from top three horizons were collected from 11 identified soil series, namely, Jambad-1, Jambad-2, Shyamnagar-1, Matalpara-1, Matalpara-2, Matalpara-3, Matalpara-4, Matalpara-5, Kharpora-1, Kharpora-2 and Dunursol-1 (mapped on 1:4000 scale) occurring on different landforms in Patloi Nala micro- watershed (684.2 ha) of district Puruliya, West Bengal. The soil samples were processed and analyzed for important soil characteristics, viz. pH (1:2.5 water), organic carbon, CEC, sand, silt and clay by using standard procedures (Jackson 1973). DTPA-extractable Zn, Cu, Fe and Mn in these soil samples were determined (Lindsay and Norvell 1978). Correlation and bivariate regression among different parameters were carried out (Panse and Sukhatme 1995). The thematic map related to DTPA-Zn was generated in GIS environment for surface soils using ArcView software.

Results and Discussion

The important physical and chemical properties of the soils have been given in table 1. The sand, silt and clay content varied from 23.2 to 88.0 per cent, 1.50 to 47 per cent and 6.80 to 36.3 per cent respectively. The sand content decreased with depth except in Matalpara-5 soil series owing to its proximity to the Patloi riverbed. The pH in surface and sub-surface horizons ranged from 4.5 to 6.1 and 4.7 to 7.9, respectively, which is a common feature of the lateritic soils of this belt (Sarkar 2003). Calcium carbonate

concretions (calcretes) were observed in the sub-surface and sub-soils of Matalpara-4. The surface soil had relatively more organic carbon (3.6-10.4 g kg^{-1}) than the underlying horizons (0.4-5.6 g kg^{-1}). The CEC and base saturation ranged from 3.1 to 22.8 cmol(p^+)kg^{-1} and 45.8 to 88.2%, respectively and in general, decreased with depth.

Table 1. Important soil physical and chemical properties

Physio graphy	Soil series and Taxonomy	Hori-zon	Depth (m)	Sand	Silt	Clay	pH (1:2.5 H_2O)	O.C. (g kg^{-1})	CEC cmol (p^+) kg^{-1}	Exch. Bases Cmol (p+) kg^{-1}	B.S. (%)
				----------%----------							
UPLAND (5-10% slope)	Jambad-1 (Typic Ustorthents)	A	0-0.11	73.7	15.8	10.5	6.1	5.5	3.1	2.3	74
	Shyamnagar-1 (Typic Haplustalfs)	Ap	0-0.09	74.4	17.1	8.5	5.3	7.6	3.5	2.2	63
		Bt1	0.09-0.40	64.0	15.2	20.8	5.8	1.2	7.3	5.0	69
		Bt2	0.40-0.60	62.4	15.8	21.8	6.0	1.0	7.8	5.5	71
	Matalpara-1 (Typic Haplustalfs)	A	0-0.11	74.0	17.0	9.0	4.9	3.6	3.1	1.8	57
		Bt1	0.11-0.34	48.5	18.6	32.9	4.8	3.2	10.2	5.3	52
		Bt2	0.34-0.56	54.6	18.5	26.9	5.0	2.6	9.0	5.2	58
	Matalpara-2 (Typic Paleustalfs)	A	0-0.11	74.0	11.9	14.1	4.6	4.3	5.3	2.8	52
		Bt1	0.11-0.47	57.6	22.3	20.1	4.7	2.9	7.6	4.1	54
		Bt2	0.47-0.86	49.2	26.9	23.9	4.9	2.2	8.8	5.1	58
	Kharpora-1 (Typic Rhodustalfs)	Ap	0-0.09	64.4	22.7	12.9	5.2	5.2	6.2	3.7	59
		Bt1	0.09-0.36	50.0	21.1	28.9	5.8	4.2	16.2	11.0	68
		Bt2	0.36-0.69	45.2	23.8	31.0	5.5	3.2	16.1	10.0	62
MEDIUM LAND (3-5% slope)	Matalpara-3 (Aquic Haplustalfs)	Ap	0-0.12	62.5	20.8	16.7	5.4	9.4	5.0	2.9	59
		Bt1	0.12-0.40	45.2	22.0	32.8	5.9	5.6	9.5	6.4	67
		Btg1	0.40-0.68	45.6	23.5	30.9	6.1	3.2	8.7	6.3	72
MEDIUM LOW LAND (1-3% slope)	Dumursol-1 (Typic Endoaqualfs)	Ap	0-0.13	61.2	24.7	14.1	4.5	9.2	8.6	4.6	54
		Btg1	0.13-0.36	59.2	20.6	20.2	6.7	2.4	9.1	6.9	76
		Btg2	0.36-0.72	40.8	27.8	31.4	6.9	2.2	14.1	11.3	80
	Kharpora-2 (Fluventic Haplustepts)	Ap	0-0.13	48.0	21.7	30.3	4.5	8.0	11.3	6.4	57
		Bw1	0.13-0.38	39.2	32.6	28.2	5.8	5.0	9.6	6.0	62
		Bw2	0.38-0.75	49.5	28.3	22.2	6.3	3.7	8.4	7.0	83
LOW LAND (0-1% slope)	Jambad-2 (Typic Endoaqualfs)	Ap	0-0.15	69.4	20.8	9.8	5.1	5.3	4.8	2.2	46
		Ag1	0.15-0.40	73.4	19.8	6.8	5.6	2.9	3.8	2.4	63
		Btg1	0.40-0.70	59.2	24.0	16.8	6.6	0.4	4.5	3.5	78
	Matalpara-4 (Typic Haplustalfs)	Ap	0-0.12	48.0	35.6	16.4	5.2	10.4	11.5	8.5	74
		Bt1	0.12-0.41	33.2	30.5	36.3	7.9	2.9	22.5	19.4	86
		Bt2	0.41-0.80	34.8	29.0	36.2	7.9	2.7	22.8	20.1	88
	Matalpara-5 (Fluventic Haplustepts)	Ap	0-0.14	23.2	47.0	29.8	5.1	7.3	13.0	7.4	57
		BW	0.14-0.35	50.8	20.0	29.2	6.2	2.8	12.2	6.9	57
		C1	0.35-0.55	88.0	1.5	10.5	6.1	1.4	3.5	1.7	50

The status of DTPA-extractable micronutrient cations (Table 2) indicates that DTPA-extractable Cu ranged from 0.38 to 2.26 $mgkg^{-1}$ and Zn from 0.24 to 0.96 $mgkg^{-1}$ against critical value (0.5-1.0 $mgkg^{-1}$) proposed by Deb and Sakal (2002). The Fe (18.8-126 $mgkg^{-1}$) and Mn (22.8-112 $mgkg^{-1}$) were higher than the critical level of Fe (2.5-5.8 $mgkg^{-1}$) and Mn (2-4 $mgkg^{-1}$) suggested by Deb and Sakal (2002). The higher contents of micronutrient in surface soils than underlying ones might be due to more organic matter addition through plant residue, and manures and fertilizers. The status of Zn (deficient/sufficient) in the watershed soils is shown in fig.1.

The statistical correlations between some important soil parameters and DTPA-extractable micronutrient cations (Table 3) indicates that clay, pH (water), CEC and base saturation had negative influence on the availability of micronutrient cations. There was significant negative correlation between pH (water) and DTPA extractable Zn (-0.48**), Fe (-0.67**) and Mn (-0.45**). Similar observations were made by Sarkar *et al.* (2000). Similarly, Fe (-0.74**) and Mn (-0.50**) showed significant negative correlation with base saturation. DTPA-Fe was also significantly but negatively correlated with CEC (-0.55**). The negative correlation between Zn and soil pH (water) might be due to the formation of insoluble zincate at higher pH (Gupta 1995). With increasing soil pH, Mn^{2+} is converted into its higher oxides (Mn^{3+}, Mn^{4+}), which are insoluble in water and, therefore, are unavailable to plants. Moreover, the increase in soil pH decreases the solubility of Mn bearing minerals like pyrulusite, manganite, etc. (Das 2000).

Table 2. Status of micronutrient cations.

Physiography	Soil series and Taxonomy	Depth (cm)	Cu	Zn	Fe	Mn
			---------- (mg kg^{-1}) ----------			
	Jambad-1 (Typic Ustorthents)	0-0.11	0.38	0.32	35.4	26.1
	Shyamnagar-1 (Typic Haplustalfs)	0-0.09	0.52	0.48	86.2	48.0
		0.09-0.40	0.42	0.40	78.9	49.2
		0.40-0.60	0.40	0.37	72.0	38.5
UPLAND (5-10% slope)	Matalpara-1 (Typic Haplustalfs)	0-0.11	1.72	0.96	110	112
		0.11-0.34	0.86	0.70	102	104
		0.34-0.56	0.88	0.68	90.3	85.4
	Matalpara-2 (Typic Paleustalfs)	0-0.11	2.26	0.71	126	96.5
		0.11-0.47	2.00	0.66	110	87.4
		0.47-0.86	1.89	0.62	105	88.6
	Kharpora-1 (Typic Rhodustalfs)	0-0.09	2.24	0.64	64.7	64.3
		0.09-0.36	2.18	0.60	62.5	55.0
		0.36-0.69	2.10	0.56	58.0	51.2
MEDIUM LAND (3-5% slope)	Matalpara-3 (Aquic Haplustalfs)	0-0.12	2.32	0.32	123	79.0
		0.12-0.40	2.26	0.25	85.5	76.4
		0.40-0.68	2.34	0.24	80.0	72.3
MEDIUM LOW LAND (1-3% slope)	Dumursol-1 (Typic Endoaqualfs)	0-0.13	2.65	0.69	82.3	76.4
		0.13-0.36	2.68	0.62	63.5	69.8
		0.36-0.72	1.94	0.40	63.2	60.9
	Kharpora-2 (Fluventic Haplustepts)	0-0.13	1.76	0.38	83.2	41.3
		0.13-0.38	1.70	0.34	58.8	23.4
		0.38-0.75	1.68	0.32	48.6	22.8
LOW LAND (0-1% slope)	Jambad-2 (Typic Endoaqualfs)	0-0.15	1.61	0.43	89.4	61.3
		0.15-0.40	1.52	0.48	85.4	60.1
		0.40-0.70	1.44	0.48	75.0	55.0
	Matalpara-4 (Typic Haplustalfs)	0-0.12	0.62	0.88	23.0	48.3
		0.12-0.41	0.38	0.45	18.8	49.0
		0.41-0.80	0.42	0.34	24.5	47.4
	Matalpara-5 (Fluventic Haplustepts)	0-0.14	0.58	0.40	88.5	61.3
		0.14-0.35	0.53	0.35	83.2	60.1
		0.35-0.55	0.50	0.32	75.0	55.0

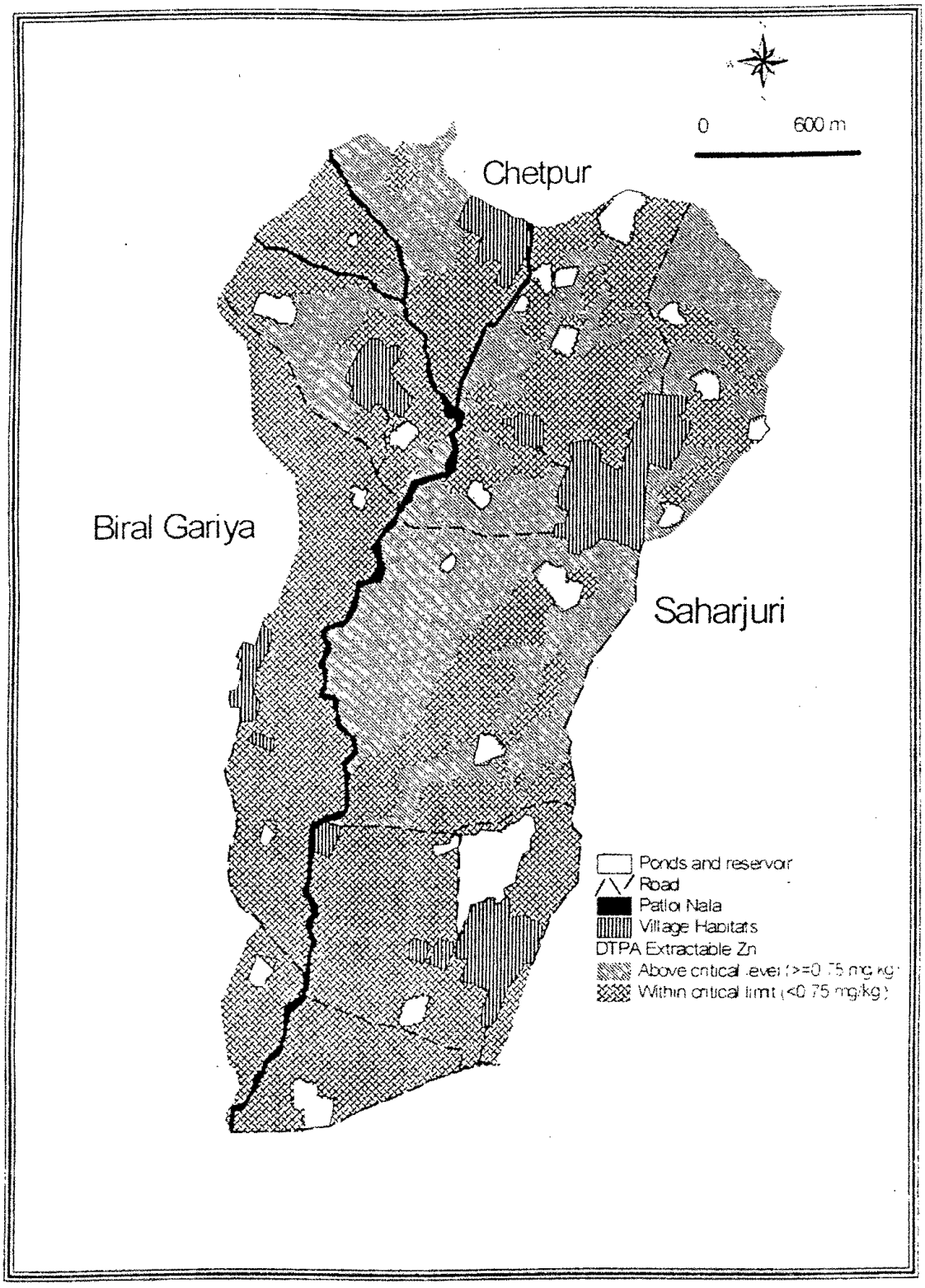

Fig. 1. Critical patches of Zinc in Patloi Nala micro-watershed, Puruliya district, West Bengal

Table 3. Statistical bivariate correlations between some important soil parameters and DTPA-extractable micronutrient cations

Soil Parameters/ Micronutrients	Sand	Silt	Clay	pH (1:2.5) H_2O)	Organic carbon (gkg^{-1})	CEC $cmol(p^+)$ kg^{-1}	Base Saturation (%)
	----------%----------						
Cu	0.023	0.015	-0.051	-0.299	0.161	-0.144	-0.189
Zn	0.185	0.005	-0.293	-0.487**	0.128	-0.097	-0.283
Fe	0.360	-0.345	-0.274	-0.670**	0.023	-0.553**	-0.745**
Mn	0.161	-0.206	-0.078	-0.456**	-0.052	-0.197	-0.502**

**Significant at 1% level

References

Das, D.K. (2000). Micronutrients: Their Behaviour in Soils and Plants. Kalyani Publishers, India. 3-126.

Deb, D.L. and Sakal, R. (2002). Micronutrients. In 'Fundamentals of Soil Science'. (Eds. G.S. Sekhon *et al.*) pp. 391-403. (Indian Society of Soil Science, New Delhi).

Gupta, V.K. (1995). Zinc Research and Agricultural Production. In Micronutrient Research and Agricultural Production. (H.L.S. Tandon Ed.), Fertilizer Development and Consultation Organisation, New Delhi, India. 132-164.

Jackson, M.L. (1973). Soil Chemical Analysis. Prentice Hall of India Pvt. Ltd., New Delhi.

Kumar, P., Sharma, S.P. and Sharma, P.D. (1996). Micronutrient status of different land forms of Soan river valley soils of lower Shiwaliks. *Journal of the Indian Society of Soil Science* **44**, 330-331.

Lindsay, W.L. and Norvell, W.A. (1978). Development of Soil Test for Zinc, Iron, Manganese and Copper. *Soil Science Society of America Journal* **42,** 421-428.

Panse, V.G. and Sukhatme, P.V. (1995). Statistical Methods for Agricultural Workers. Published by Indian Council of Agricultural Research (ICAR), New Delhi, India. 97-123.

Sarkar, Dipak, Haldar Abhijit, Majumdar Alok and Velayutham, M. (2000). Distribution of micronutrient cations in some Inceptisols and Entisols of Madhubani district, Bihar. *Journal of the Indian Society of Soil Science* **48**, 202-205.

Sarkar, Dipak (2003). Soil resource information for meeting challenges of land degradation:A case study in Chotanagpur Plateau Region. *Journal of the Indian Society of Soil Science* **50**, 414-437.

Vijay Kumar, T., Suryanarayanan Reddy, M. and Gopalakrishna, V. (1996). Vertical distribution of micronutrient cations in some profiles in Northern Telengana of Andhra Pradesh. *Journal of the Indian Society of Soil Science* **44**, 328-330

Received : July 2005 *Accepted : November 2009*