Agropedology, 2001, 12, 50-56

Status of available Co, Zn, Cu, Mn and Fe in some soils of plateau region of Jharkhand.

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Abstract

Two hundred fifteen surface soil samples representing four major soil series of Jharkhand Plateau were studied for available Co, Zn, Cu, Mn and Fe status. In general, the availability of these micronutrients was high in soils of Karaya series and low in Bandhi series. All the soils were sufficient in Cu but 9.2 to 40.0, 1.5 to 22.0, 2.0 to 56.0 and 6.0 to 12.0 per cent of soils were dificient in Zn, Mn, Fe and Co, respectively. The availability of these micronutrients were significantly and positively correlated among themselves. Zn, Mn, Fe and Co were negatively correlated with pH as well as with sand content. These nutrients were positively correlated with organic carbon, silt and clay content of respective soils. However, availability of Co and Mn did not have any relation with organic carbon and clay. Hence, it appeared that soils of Jharkhand platenu with low values of pH and organic carbon are sufficient in supply of available reserve of micronutrients even without their external application under low cropping intensity conditions.

Additional keywords : Acid soil, soil characteristics.

Introduction

Though the earlier studies (Sakal *et al.* 1988; Singh and Choudhary 1990) showed that the availability of DTPA extractable micronutrients was affected by soil properties (pH, organic carbon, sand, silt and clay content), however, the variation in DTPA extractable Co, Zn, Cu, Mn and Fe in relation to these soil characteristics may not be uniform for all soils in general, and acid soils in particular. Information on the status and availability of these micronutrients are scanty (Kumar *et al.* 1994) for this region. Moreover, status of Fe and Mn in acid soils of Jharkhand region usually affect the productivity of some crops due to some adverse effect on the availability of different micronutrients including Co and Zn (Singh *et. al.* 1992). Keeping this in view, the present investigation was carried out to assess the status of micronutrients *viz.* Co, Zn, Cu, Mu and Fe in different agriculturally important soil series of Jharkhand plateau. The information at series level may be helpful to be extrapolated elsewhere.

Materials and methods

Two hundred fifteen surface soil samples (0.0-0.15m) were collected from Debatoli series of Jumar river sub-catchment area of Ranchi, Bandhi series of Subarnarekha command area of Singhbhum, Pusaro and Karaya series of Dumka. Soils of Debatoli series are characterised by poorly drained, moderately deep to very deep soils occupying mostly

Table 1 : Physical and chemical characteristics of soils.

Soil properties	Soil Series											
	Debatoli (65)[1]			Bandhi (50)[1]			Pusaro (50)[1]			Karaya (50)[1]		
	Range	Mean	S.D[2]	Range	Mean	S.D[2]	Range	Mean	S.D[2]	Range	Mean	S.D[2]
pH	5.0 - 6.2	5.60	-	4.9 - 5.8	5.35	-	3.9 - 6.3	5.10	-	4.3 - 7.9	6.1	-
Organic carbon (g kg-1)	3.36 - 8.69	6.32	1.26	1.33 - 7.69	3.10	1.33	1.21 - 4.56	2.90	0.90	1.23-4.79	3.27	1.10
Sand (%)	63.0 - 80.0	67.6	4.14	26.4 - 70.7	47.3	10.32	46.00 - 86.40	66.79	9.15	31.2 - 72.8	51.77	11.53
Silt (%)	6.4 - 23.2	17.8	4.77	8.4 - 56.4	29.5	10.97	6.00 - 32.20	23.20	7.06	9.6 - 40.4	22.05	8.66
Clay (%)	9.6 - 21.6	14.5	2.14	12.8 - 36.8	23.2	5.73	3.60 - 30.20	10.01	3.72	17.6 - 37.2	26.18	5.45

1. Figure in parenthess indicate total number of soil samples.
2. S. D. Standard deviation.

medium upland with 1-3 per cent slope. The soil colour varies from yellowish brown (10 YR 5/4) to yellow (10 YR 8/6), very strongly to slightly acidic and sandy loam to sandy clay loam in texture. Soils of Bandhi series are characterised by light textured surface soils, underlain by murrum and occur on upland (terraced) with 2 to 5 per cent slope. The soil colour varies from reddish brown (2.5 YR 4/4) to reddish yellow (5 YR 6/8), very strongly to medium acidic and sandy loam to silty clay in texture. Pusaro soils are well drained with moderate permeability occupying mostly upland with less than 5 per cent slope. The colour varies, from strong brown (7.5 YR 5/6) to yellowish red (5 YR 4/6), extremely to strongly acidic, loamy sand to loam in texture. Karaya sols are poorly drained on upland to lowland physiography with 1 to 3 per cent slope and nil to slightly eroded. The colour varies from dark yellowish brown (10 YR 3/4) to strong brown (7.5 YR 5/8), extremely acidic to moderately alkaline, sandy loam to sandy clay loam texture.

The processed soil samples (<2mm) were analysed for important soil characteristics, like pH, organic carbon and various particle size fractions using standard procedures. Some available micronutrients in soil *viz.* Co, Zn, Cu, Mn and Fe were extracted with DTPA-$CaCl_2$-TEA solution (Lindsay and Norvell 1978) and determined with the help of atomic absorption spectrophotometer. Data were analysed by statistical procedure as outlined by Fisher (1950). Correlation analysis was done by standard methods (Snedecor and Cochran 1967).

Results and discussion

Soil properties : The soils under study are sandy loam to clay loam in texture. These soils (Table 1) are extremely acidic to moderately alkaline (Soil Survey Staff 1997) in pH (3.9 to 7.9) and low to medium in organic carbon (2.90 to 6.32 g kg^{-1}).

Available Cobalt : The available Co content of the soils of Debatoli, Bandhi, Pusaro and Karaya series (Table 2) varied from traces to 3.91 mg kg^{-1} with a mean values of 0.95, 0.59, 0.84 and 1.81 mg kg^{-1} soil, respectively. The highest amount of available Co in soils of Karaya series might be due to higher clay content as compared to others. Considering 0.25 mg kg^{-1} of available Co as the critical limit (Stewart 1953) in soil, 10.8, 6.0, 6.0 and 12.0 per cent soil samples of Debatoli, Bandhi, Pusaro and Karaya series were deficient in available Co. Available Co was significantly and positively correlated with clay, Zn, Cu, Mn and Fe contents of soil but negatively correlated with soil pH (Table 3). Similar observations were also reported by Azad *et al.* (1986) with respect to pH.

Available Zinc : DTPA extractable Zn in these soil series ranged from traces to 3.84 mg kg^{-1} (Table 2). It was the highest amount in soils of Debatoli series (1.80 mg kg^{-1}) and lowest in Bandhi series (0.77 mg kg^{-1}). According to Katyal (1985) who suggested the critical limit as 0.6 mg kg^{-1} of soil, the soils under study show that 9.2 per cent soils of Debatoli and 40.0 per cent soils of Bhandi series are deficient in DTPA extractable Zn.

Table 2. Available micronutrients of various soils

Micro nutrients	Soil Series															
	Debatoli (65)[1]				Bandhi (50)[1]				Pusaro(50)[1]				Karaya (50)[1]			
mg kg^{-1}	Range	Mean	S.D.[2]	P.S.D.[3]	Range	Mean	S.D.[2]	P.S.D.[3]	Range	Mean	S.D.[2]	P.S.D[3]	Range	Mean	S.D.[2]	P.S.D[3]
Zn	Tr.-3.84	1.80	0.83	9.22	0.44-1.80	0.77	0.29	40.0	0.73-1.97	1.35	0.66	nil	0.71-2.91	1.52	0.46	nil
Cu	1.81-5.32	3.48	1.09	nil	0.60-3.89	1.59	0.72	nil	0.65-2.49	1.45	0.53	nil	1.53-9.26	4.28	1.60	nil
Mn	0.83-15.01	8.98	4.25	1.54	1.19-7.42	3.46	1.78	22.0	3.58-14.40	11.29	2.38	nil	5.74-14.73	12.39	2.28	nil
Fe	10.28-27.32	23.66	4.00	nil	1.37-20.61	5.69	4.57	56.0	0.76-29.63	23.44	5.86	2.00	8.13-29.45	24.11	5.25	nil
Co	0.01-2.88	0.95	0.74	10.77	0.11-2.04	0.59	0.36	6.0	0.03-2.53	0.84	0.50	6.00	Tr.-3.91	1.81	1.20	12.00

1. Figure in parentheses indicate total number of soil samples.
2. S.D. : Standard deviation.
3. P.S.D. : Per cent soil sample deficient

Table 3. Correlation coefficient(r) between available micronutrients and soil properties.

Soil Properties	Zn	Cu	Mn	Fe	Co
pH	–0.163*	–0.079	–0.403**	–0.244**	–0.167*
Organic carbon	0.241**	0.306**	–0.011	0.260**	–0.015
Silt	0.159*	–0.066	0.292**	0.298**	0.066
Clay	0.332**	0.232**	0.123	0.359**	0.223**
Zn		0.318**	0.478**	0.555**	0.205**
Cu	-	-	0.280**	0.198**	0.495**
Mn	-	-		0.575**	0.378**
Fe	-	-	-	-	0.413**

* Significant at 5% level.

** Significant at 1% level.

Simple correlation study (Table 3) indicated that available Zn had a positive relationship with organic carbon, silt and clay content of soils and it was negatively correlated with soil pH.

Available Copper : The available Cu in the soils varied from 0.60 to 9.26 mg kg^{-1} (Table 2). The available Cu was the highest (4.28 mg kg^{-1}) in Karaya and lowest in (1.45 mg kg^{-1}) Pusaro series which may be due to variation in clay content. All the soils are found to be adequate in DTPA extractable Cu (Katyal and Randhawa 1983) as 0.2 mg Cu kg^{-1} soil is considered the threshold value. Available Cu was positively correlated with organic carbon, clay and Zn. This is in accordance with the earlier report of Chatterjee and Khan (1997).

Available Manganese : A wide variation in the DTPA extractable Mn (0.83 to 15.01 mg kg^{-1}) was observed in the different soils series (Table 2) with minimum in Bandhi series (3.46 mg kg^{-1}) and the maximum in Karaya series (12.39 mg kg^{-1}). Such variations in Mn status of acid soil of Jharkhand plateau have also been reported by Sakal *et al.* (1996). Considering 2.0 mg kg-1 soil of DTPA extractable Mn as critical limit (Takkar *et al.* 1989), only 1.54 per cent soils of Debatoli and 22 per cent of Bandhi series were deficient in available Mn. Kumar *et al.* (1994) also reported higher DTPA extractable Mn content in the soil of Chotanagpur plateau. A positive and highly significant relation existed among available Mn with silt, Zn and Cu but reverse relationship of its nutrient were also reported with pH (Khan *et al.* 1997).

Available Iron : DTPA extractable Fe content in these soil series varied from 0.76 to 29.63 mg kg^{-1} (Table 2). Sakal *et al.* (1996) also reported higher content of available Fe in the soils of plateau region of Jharkhand. The highest content of available Fe was observed

in soils of Karaya series (24.11 mg kg^{-1}) and lowest in Bandhi series (5.69 mg kg^{-1}). 56 and 2 per cent soil samples of Bandhi and Pusaro series, respectively are found to be deficient in available Fe, and soils of the Debatoli and Karaya series are sufficient in DTPA Fe when we consider 4.5 mg kg^{-1} soil as threshold value for DTPA extractable Fe in soil (Katyal and Randhawa 1983). Highly significant positive correlation existed between available Fe and silt, clay, Zn, Cu and Mn whereas there is a negative relationship with soil pH. Similar observations were also reported by Datta and Ram (1993) with respect to organic carbon, clay and Cu.

The study indicated that soils of plateau region are acidic in nature having poor organic matter. Soil pH, organic carbon and texture significantly affected the availability of Zn, Cu, Mn, Fe and Co. In general, soils are sufficient in cationic micronutrients. Thus, regular dressing of these micronutrients is very essential in these soils for higher crop production. A balanced use of other nutrients in organic and inorganic source, seems to be essential for sustainable crop production and soil health.

Acknowledgement

The first author is grateful to Dr. H. K. Roy, University Professor-cum-Chief Scientist (Retd.), Department of Soil Science and Agricultural Chemistry, Birsa Agricultural University, Ranchi under whose guidance the present investigation was carried out.

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Recived : October, 2000; Accepted : July, 2002