AGROPEDOLGY, 5; 1995

Micronutrients in Soils, Clays and Concretions in Vertisols of Bihar

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Abstract: *The total content of micronutrient elements do not show a sharp and regular trend of variation. However, Zn and Fe have tendency of decreasing with depth. The variation in these elements seems to be associated with parent materials, organic carbon, clay and pH and controlled by the vertic characters of soils. DTPA- Zn, Cu, Fe and Mn show decreasing trend with depth within the pedons. These extractable elements are higher in Chour land soils than those of sedentary and old alluvial. The variation of these elements is attributed mainly to pH and orgainc matter.*

Total content of Zn, Cu and Fe is highest in nodules and concretions followed by clays and then in soils; while total Mn is highest in nodules and lowest in clays. Zinc shows the tendency to be associated first with Clay size fractions, which ultimately form a part of concretions. (***Key words:*** *Parent material, Vertic, DTPA, Sedentary, Old alluvial, nodules, Concreations, Clays)*

Vertisols and associated soils of Bihar are both clayey and concretionary. The information on micronutrient status of these soils and their distribution in clays and concretions is very limited. In the present study, therefore, an attempt has been made to assess the total content and DTPA extractable Zn, Cu, Fe and Mn in soils, clays and concretions.

MATERIAL AND METHODS

Five pedons from Vertisols and associated soils occurring in part of Nawadah, Rohtas, Bhojpur and Begusurai districts which spread between 21°31'N Lat., and 84°11' and 86°10' E Long. were selected. Total Zn, Cu, Fe and Mn in soils, clays and concretions were determined from the extract obtained after fusing them with anhydrous Na_2CO_3. The available micronutrient elements were determined by extracting the soils with DTPA (Lindsay & Norvell 1978). The elemental analysis was done with the help of Atomic Absorption Spectrophotometer.

RESULTS AND DISCUSSION

Soils : The data on total and DTPA extractable micronutrients in soils have been presented in Table 1 and that of clay, concretion and nodules in Table 2.

Zinc : There is no regular pattern of the distribution of total Zn and DTPA. Zn in the profile. However, they tend to decrease with the depth. This variation might be attributed to the vertic character of these soils. It is also observed that the Chourland soils (young alluvial) have higher total and DTPA-Zn than those of sedentary and old alluvial soils. This is probably due to their parent materials.

Copper : Total Cu content do not show any regular trend of distribution. However, DTPA - Cu shows almost decreasing trend with depth. Similar observations were recorded by Kanwar and Tripathi (1986) and Diwakar and Singh (1992). The DTPA - Cu seems to be more influenced by pH and organic matter contents and less by slit and clay.

It is also confirmed by its highly significant -ve correlation with pH and +ve with organic carbon. It is further supported by higher DTPA - Cu in Chourland

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TABLE 1. Micronutrient status in Vertisols and associated soils of Bihar.

Depth	Horizon	Total (ppm)				DTPA extractable (ppm)			
(cm)		Zn	Cu	Fe	Mn	Zn	Cu	Fe	Mn
SEDENTARY SOILS :	*PEDON 1, SHAHPUR, LOW LAND, UDIC CHROMUSTERTS*								
0-35	Ap	90	150	22800	500	0.7	0.7	8.9	9.0
35-62	A11	40	80	21800	690	1.2	1.1	7.8	9.7
62-88	A12	50	80	20700	630	1.1	1.1	7.8	8.0
88-135	AC	330	310	20300	500	0.9	1.9	5.6	3.7
	PEDON 2, UPARIDIH, UPLAND, UDIC CHROMUSTERTS								
0-22	A	130	120	18900	380	0.9	0.9	7.8	8.3
22-73	A11	130	150	22100	380	0.8	0.9	6.7	6.7
73-130	A12	50	40	20700	440	0.9	0.8	6.7	6.3
OLD ALLUVIAL SOILS:	*PEDON 3, KARAINI, LOWLAND, UDORTHENTIC CHROMUSTERTS*								
0-20	AP	60	80	22500	380	0.6	1.5	10.0	10.0
20-60	A11	100	80	23200	380	0.4	1.3	11.1	8.0
60-107	A12	100	120	22800	310	0.7	1.5	7.8	4.7
107-155	A13	80	190	23900	380	0.6	1.6	8.9	4.0
	PEDON 4, KARMAINI, UPLAND, UDORTHENTIC CHROMUSTERTS								
0-30	AP	100	150	24300	380	0.7	1.3	7.8	8.7
30-57	A11	80	270	22100	250	0.6	1.3	6.7	4.7
57-92	A12	130	120	23900	310	0.6	0.8	6.7	4.3
92-130	A13	100	80	25300	380	0.4	0.7	4.4	4.0
130-155	AC	100	190	19300	380	0.4	0.5	4.4	4.3
YOUNG ALLUVIAL SOILS :	*PEDON 5, KUSHMHAUT CHOUR, LOW LAND, VERTIC USTORTHENTS*								
0-21	AP	140	90	23600	320	1.8	5.2	45.4	9.6
21-44	A1	120	110	22400	300	1.7	4.6	48.6	8.2
44-62	IIC	130	120	26500	300	0.9	3.9	62.3	12.8
62-91	IIIC	120	120	21000	250	0.5	2.8	35.1	8.6
91-120	IVC	100	210	15600	310	0.6	1.3	20.4	6.9

soils, which have relatively higher organic matter and lower pH.

Iron : Total and DTPA-Fe does not show clear trend of variation within the Pedons, but they tend to decrease with the depth. It is further observed that DTPA-Fe in Chourland soils is higher than those of sedentary and old alluvial. They seem to be related with the parent materials, pH and organic carbon content of the soils. It is supported by highly significant -ve correlation of DTPA-Fe with pH +ve correlation with organic carbon (Table 3).

Manganese : The total Mn does not show any trend

TABLE 2. Total micronutrient elements in clays and concretions (ppm)

Depth	Total elements in clay				Total elements in concretions				Total elements in nodules			
(cm)	Zn	Cu	Fe	Mn	Zn	Cu	Fe	Mn	Zn	Cu	Fe	Mn
SEDENTARY SOILS : *PEDON 1, SHAHPUR, LOW LAND, UDIC CHROMUSTERTS*												
0-35	200	120	37300	250	180	80	11700	2500	250	150	24400	63300
88-135	180	190	43200	250	200	150	12200	1300	300	150	35000	20800
PEDON 2, UPARIDIH, UPLAND, UDIC CHROMUSTERTS												
0-22	230	120	43200	130	250	230	9400	1400	350	460	125700	35800
73-130	80	80	35300	310	550	690	10600	1000	350	150	125700	33000
OLD ALLUVIAL SOILS: *PEDON 3, KARMAINI, LOWLAND, UDORTHENTIC CHROMUSTERTS*												
0-20	200	120	39300	130	250	230	13300	1400	300	150	165000	46800
107-155	100	120	47100	310	450	770	15000	2300	350	80	180700	38500
PEODN 4, KARMAINI, UPLAND, UDORTHENTIC CHROMUSTERTS												
0-30	130	40	47100	250	380	380	18700	2800	630	190	176800	25000
130-155	100	150	39300	380	200	150	15600	3000	750	190	89300	31300
YOUNG ALLUVIAL SOILS: *PEDON 5, KUSHMAUT CHOUR, LOWLAND, VERTIC USTORTHENTS*												
0-21	220	140	38500	230	-	-	-	-	-	-	-	-
91-120	170	130	49400	360	-	-	-	-	-	-	-	-

of variation, while DTPA-Mn indicates a decreasing trend with the depth. Total Mn seems to be controlled mainly by parent materials and clays, whereas DTPA-Mn by organic matter, $CaCO_3$ and silt content. It is also evident from the significant correlation of DTPA-Mn with organic carbon content and also close relation with pH, $CaCO_3$ and silt contents (Table 3).

Clays : The data on total micronutrient elements in clays (Table 2) indicate that Zn, Cu and Fe are higher in clays than the soils, while Mn is observed to be higher in soils. It is probably due to less inclusion of Mn during crystallization of clays in presence of higher amount of Fe. It varies widely in clays. This also provides an indication towards tendency of their precipitation and formation of ferruginous nodules with micronutrients as their constituents.

Concretions and Nodules : It is observed that the appearence of higher concentration of Zn, Fe and Mn in ferrugenous nodules than that of $CaCO_3$ concretions.

Comparative Study : In general, the elements (Zn, Cu & Fe) are highest in nodules and concretions followed by clays and soils. Particularly, in case of Zn, there is tendency to be associated first with clay size fractions which ultimately form a part of concretions.

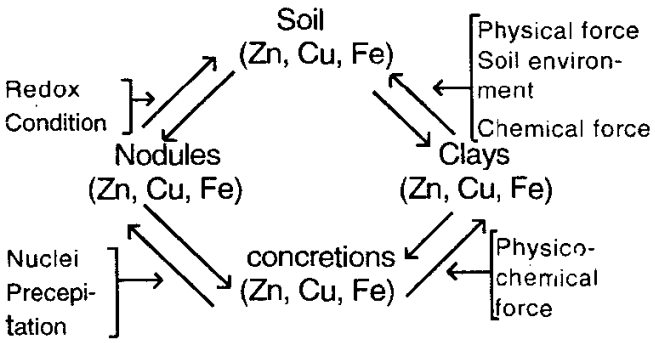
Copper and iron also show to some extent the similar behaviour as that of Zn. This process has

TABLE 3. Correlation coefficient (r) between soil properties

DTPA-extractable elements	Soil properties					
	pH	Org. C	$CaCO_3$	Clay	fine clay	Silt
Zn	-0.3607	0.6368**	-0.0204	0.2617	0.0993	0.4530*
Cu	-0.7090**	0.6013**	-0.0964	0.1869	0.1235	0.2590
Fe	-0.6567**	0.4427*	-0.2351	0.0110	-0.0650	0.3741
Mn	-0.4077	0.5022	-0.3906	0.0784	-0.1301	0.4099

* Significant; ** Highly significant

been shown diagrammatically as below :



Manganese shows quite different behaviour from Zn, Cu and Fe. The clay is generally found lower in Mn content than the associated soils, but it is always higher in nodules and concretions than the associated soils and clays. This is further strengthend by the fact that during the formation of nodules and concretions, manganese is precipitated first followed by the precipitation of Fe when Mn is exhausted (Schwertmann & Fannning 1976). This also leads to believe that clays along with the coarser fractions would have acted as nuclei for the formation of concretions and nodules. Generally, these concretions and nodules are used as nuclei for the precipitation of iron and manganese oxides and calcium carbonate, respectively.

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