

Characterization and classification of some Vertisols of western zone in Orissa

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Abstract

Four Vertisol pedons in the Western Zone of Orissa were morphologically studied, characterised and classified. The soils are very deep, colour ranges from black (10YR 2/1) to grayish brown (10YR 5/2) in different horizons, crack of 2 to 3 cm wide extends beyond one metre. Slickensides, wedge shaped aggregates, Fe, Mn and calcretes are observed in the sub-surface horizons of the soils. The soils are imperfectly drained, slightly acid to moderately alkaline, and the pH value increased with depth. The soils are base rich and high in CEC : clay ratio (0.65 to 0.75) and are classified as Typic/Chromic Haplusterts.

Additional key words : Soil morphology, physical and chemical characteristics, Taxonomy.

Introduction

In Orissa, Vertisols occupy 0.86 m ha (Sarkar *et al.* 1998) mainly in the districts of Kalahandi, Bolangir and Nuapada. The dominant soil constraints are unfavourable tilth, wide and deep shrinkage cracks, slow saturated hydraulic conductivity in the sub-soil, and prone to erosion in the uplands. However, systematic information on characteristics of these Vertisols is rather limited in Orissa and hence present investigation was carried out.

Materials and Methods

The study was carried out at Regional Research Station of the University located at Bhawanipatna in Kalahandi district representing western part of agro-climatic zone. The average mean annual rainfall is 1354 mm. and the climate is hot and moist sub-humid. It is a valley plain surrounded by hills and hillocks. Four pedons were morphologically described (Soil Survey Division Staff 1995). Physical and chemical analysis of soil samples from each horizon of the pedons were carried out following standard procedure. The soils were classified as per Soil Taxonomy (Soil Survey Staff 1998).

Results and Discussion

Morphology: Some salient morphological characteristics of the pedons are presented in table 1. The colour of the soil is in 10YR, value ranges from 2 to 5 and chroma 1 to 2 and the low chroma indicates poor drainage of the soils. The dark colour in these soils may be partly due to high content of ilmenite along with other dark coloured ferromagnesian minerals (Sahu *et al.* 1982). The structure ranges from medium, moderate subangular blocky to coarse strong subangular blocky through depth. Cracks of 1 to 3 cm wide and gilgai micro-relief are the normal surface features in the area.

These soils have slickensides and shiny pressure faces in the subsurface horizon indicating shrink swell properties of the soils. Presence of Fe-Mn concretions in all the subsurface horizons is attributed to slow to very slow permeability and reduction-oxidation cycle. Fine to coarse irregular calcretes are observed in the lower horizons of all the pedons and they increased with depth.

Table 1. Morphological characteristics of the soils

Horizon	Depth (cm)	Colour (moist)	Texture	Structure	Cracks (cm wide)
Pedon 1 - Chromic Haplusterts					
Ap	0-14	10YR 5/2	cl	m2 sbk	2-3
Bw	14-35	10YR 4/1	c	m3 abk	1-2
Bss1	35-57	10YR 4/2	c	c3 abk	1-2
Bss2	57-125	10YR 3/2	c	c3 abk	1-2
Pedon 2 - Chromic Haplusterts					
Ap	0-12	10YR 4/1	c	m2 sbk	2-3
Bw	12-30	10YR 4/1	c	c3 abk	1-2
Bss1	30-42	10YR 4/2	c	c3 abk	1-2
Bss2	42-135	10YR 4/1	c	c3 abk	1-2
Pedon 3 - Chromic Haplusterts					
Ap	0-12	10YR 4/2	cl	m2 sbk	2-3
Bw	12-40	10YR 2/1	c	c3 abk	1-2
Bss1	40-65	10YR 3/1	c	c3 abk	1-2
Bss2	65-130	10YR 4/1	c	c3 abk	1-2
Pedon 4 - Typic Haplusterts					
Ap	0-12	10YR 3/1	c	c3 abk	2-3
Bss1	12-30	10YR 2/1	c	c3 abk	1-2
Bss2	30-68	10YR 2/1	c	c3 abk	1-2
Bss3	125	10YR 3/1	c	c3 abk	1-2

The abbreviations are as per Soil Survey Manual (Soil Survey Division Staff, 1995)

Physical and chemical characteristics: Particle size distribution (Table 2) indicates an increase in clay content in the subsoils. Except pedon 4, the bulk density values are comparatively higher ($.38$ to 1.43 mg m^{-3}) in surface horizons than the sub-surface horizons and particle density values remain uniform (2.65 to 2.78 mg m^{-3}) throughout (data not reported here) the depth of the profiles.

Soil reaction is slightly acid to moderately alkaline in P1, P2 and P3 soils and slightly alkaline to moderately alkaline in P4. There is a gradual increase of pH down the profile which is a characteristic feature of Vertisols (Subbaiah *et al.* 1992). The electrical conductivity values are invariably low ranging from 0.07 to 0.43 dSm^{-1} . In general, level of organic carbon decreases with depth. The content of free CaCO_3 in these soils increases with depth and it ranges from 10 to 72 g kg^{-1} .

Table 2. Physical and chemical characteristics of the soils

Depth (cm)	Sand	Silt	Clay	B.D. (Mg m ⁻³)	pH _w	Org. C (g kg ⁻¹)	CaCO ₃ (g kg ⁻¹)
	(%)						
Pedon-1							
0-14	57.6	11.8	30.6	1.43	6.5	4.1	10
14-35	45.6	13.8	40.6	1.33	7.0	4.0	12
35-57	44.6	13.8	41.6	1.32	7.4	3.9	17
57-125	45.6	12.8	41.6	1.31	7.4	3.6	22
Pedon-2							
0-12	45.6	14.8	39.6	1.38	6.8	6.7	30
12-30	37.6	15.8	46.6	1.33	7.0	3.1	42
30-42	37.6	13.8	48.6	1.31	7.2	2.7	50
42-135	37.6	13.8	48.6	1.32	7.7	3.3	66
Pedon-3							
0-12	60.6	11.8	31.6	1.41	6.5	7.0	16
12-40	45.6	16.8	37.6	1.38	6.7	6.0	20
40-65	44.6	13.8	41.6	1.31	6.9	5.2	32
65-130	42.6	12.8	44.8	1.31	7.2	4.8	57
Pedon-4							
0-12	38.6	12.8	48.6	1.25	7.4	11.9	40
12-30	38.6	11.8	49.6	1.26	7.9	6.0	42
30-68	36.6	11.8	51.6	1.28	8.2	4.5	50
68-125	35.6	11.8	52.6	1.30	8.4	4.2	72

The CEC values of the soils (Table 3) varied from 13.21 to 34.72 cmol(p⁺)kg⁻¹ and increased with depth showing its direct relationship with clay content ($r = 0.99$). The exchange complex is mostly saturated with Ca²⁺ followed by Mg²⁺, Na⁺, and K⁺. The exchangeable Mg²⁺ and Na⁺ increased and Ca²⁺ remained almost constant with depth. It is assumed that Na and Mg salts are relatively more soluble than the Ca salts and leached down to lower layers (Krishnamurthy and Govindarajan 1977). The soils are highly saturated with bases (88.6 to 98.4%). Higher ratio of CEC : clay (0.65 - 0.75) is due to smectitic minerals.

Table 3. Exchange characteristics of the soils

Depth (cm)	CEC	Exchangeable cations				Base saturation (%)	CEC/Clay ratio
		Ca ⁺⁺	Mg ⁺⁺	Na ⁺	K ⁺		
	-----cmol (p ⁺) kg ⁻¹ -----						
Pedon-1							
0-14	22.88	17.9	3.3	0.4	0.4	96.2	0.75
14-35	28.20	20.9	5.3	0.8	0.4	97.2	0.69
35-57	28.28	17.6	8.3	0.7	0.6	96.2	0.68
57-125	27.76	16.9	8.7	0.9	0.5	97.3	0.67
Pedon-2							
0-12	28.51	19.6	6.0	0.8	0.4	94.0	0.72
12-30	31.68	19.3	8.6	0.9	0.5	92.5	0.68
30-42	32.08	18.2	11.3	1.0	0.5	96.6	0.66
42-135	31.59	17.9	10.0	0.9	0.7	93.4	0.65
Pedon-3							
0-12	23.07	17.0	4.3	0.9	0.5	98.4	0.73
12-40	25.94	16.3	6.3	0.8	0.4	91.8	0.69
40-65	27.87	15.6	9.3	0.9	0.5	94.4	0.67
65-130	28.99	14.9	11.6	1.0	0.6	96.9	0.65
Pedon-4							
0-12	34.02	23.5	6.0	1.6	1.0	94.4	0.70
12-30	34.22	22.0	6.3	2.6	0.9	92.9	0.69
30-68	34.57	21.3	7.3	3.5	0.8	95.2	0.67
68-125	34.72	20.0	8.0	3.9	0.9	94.5	0.66

Classification: Based on morphological, physical and chemical characteristics, the soils are classified as Chromic Haplusterts (P1, P2 and P3) and Typic Haplusterts (P4) at sub-group level. These soils have fine textural family, smectitic mineralogy and hyperthermic soil temperature regime.

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