Characterization and classification of some soils of Arunachal Pradesh

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Abstract
Six pedons collected from different parts of Arunachal Pradesh were studied for characterization and classification. The influence of parent material was observed on colour, texture, and pH of the soils. The soils are acidic in nature. High organic carbon and CEC were observed in the surface horizons. CEC was found to be related to organic carbon content rather than the clay content of the soils. The soils were classified as Typic Dystrochrepts, Typic Paleudults, Aeric Endoaquults, Umbric Dystrochrepts and Ruptic-Ultic Dystrochrepts.

Additional keywords: Parent material, epipedon, Soil Taxonomy.

Introduction

The soils of Arunachal Pradesh are developed on sedimentary and metamorphic rocks of varying geological age and also in alluvium derived from these rocks. Pedogenic characterization of these soils is of importance for land use planning and soil resource management under the existing sub-humid to humid climatic conditions. The present investigation was undertaken to characterize and classify some soils developed on different parent materials in Arunachal Pradesh.

Materials and methods

Six pedons developed on different parent materials were collected from Yachuli (P1), Kaying (P2), Mon (P3), Roing (P4), Bordumsa (P5) and Tupi (P6) of Arunachal Pradesh. The study area is characterized by humid to sub-humid climatic conditions with mean annual rainfall of 3800 to 4500 mm in Yachuli, Kaying, Roing, Bordumsa and about 8000 mm in Tupi area. The soil temperature regime is thermic in Yachuli and Kaying which experience snowfall during winter. In other areas, it is hyperthermic where temperature may increase upto 38°C during summer. The physiography of the area consists of low hills (P1, P2, P3), intermountain valley (P4) and extension of the Brahmaputra valley (P5, P6). The parent materials are mica-schists (P1), shale (P2), quartzite intercalated with phyllite (P3), alluvium derived from quartz-phyllite schists, biotite (P4) and alluvium derived from quartzite and phyllite (P5, P6).

Soils were studied for soil morphology (Anonymous 1971) and horizonwise soil samples were analysed for mechanical composition (Piper 1966), soil reaction (1:2.5), organic matter, CEC, exchangeable cations and base saturation (Jackson 1973). Classification of the soils was done as per Keys to Soil Taxonomy (Soil Survey Staff 1994).

Results and discussion

Morphological characteristics

The morphological characteristics of the soils are presented in table 1. The colour of the soil varied from very dark brown (10YR 3/3) to dark yellowish brown (10YR 4/4) in the surface and dark brown (10YR 4/3) to yelllowish brown (10YR 5/6) in the subsurface horizons of P1, P3, P4 and P5. The soils of P2 showed strong brown colour (7.5YR 4/5 to 7.5YR 4/6) throughout the profile. This may be due to advanced stage of

Table 1. Morphological characteristics of the soils

Horizon	Depth (cm)	Colour (moist)	Textural class	Structure	Consistence
		P1 (Yachuli) Typic Dystrochrepts			
Ap	0-30	10YR 4/4	scl	gr - sbk	wss, wsp
Bw1	30-50	10YR 4/6	scl	sbk 1m	wss, wsp
Bw2	50-70	10YR 5/7	scl	sbk 2m	wss, wsp
2Bw3	70-120	10YR 4/6	scl	sbk 2m	wss, wsp
2Bw4	120-150	10YR 5/6	scl	sbk 2m	wss, wsp
		P2 (Kaying) Typic Paleudults			
Ap	0-15	7.5YR 4/5	scl	gr	wss, wsp
Bt1	15-30	7.5YR 4/6	c	sbk 2m	ws, ws
Bt2	30-60	7.5YR 4/6	c	sbk 3m	ws, wp
Bt3	60-90	7.5YR 4/5	c	sbk 3m	ws, wp
Bt4	90-120	7.5YR 4/5	c	sbk 2m	ws, wp
		P3 (Mon) Typic Dystrochrepts			
Ap	0-15	10YR 4/4	scl	gr	wss, wsp
Bw1	15-30	10YR 4/5	scl	sbk 1m	wss, wsp
Bw2	30-60	10YR 5/5	scl	sbk 1m	wss, wsp
2Bw3	60-90	10YR 4/5	scl	sbk 2m	wss, wsp
2Bw4	90-120	10YR 5/5	scl	sbk 1m	wss, wsp
		P4 (Roing) Aeric Endoaquults			
Ap	0-15	2.5Y 4/3	cl	gr	wss, wsp
Bt1	15-30	2.5Y 4/3	c	sbk 1m	wss, wp
2Bt2	30-60	2.5Y 3/2	sc	sbk 2m	wss, wsp
2Bt3	60-90	2.5Y 3/2	sc	sbk 2m	wss, wsp
3C	90-120	2.5Y 3/2	scl	m	wss, wsp
		P5 (Bordumsa) Umbric Dystrochrepts			
Ap	0-15	10YR 3/3	scl	m	wss, wsp
BA	15-30	10YR 4/3	scl	sbk 1f	wss, wsp
Bw1	30-60	10YR 4/4	sc	sbk 1m	wss, wsp
Bw2	60-90	10YR 4/5	cl	sbk 1m	wss, wsp
C	90-120	10YR 4/6	scl	m	wss, wsp
		P6 (Tupi) Ruptic-Ultic Dystrochrepts			
Ap	0-15	10YR 4/3	cl	gr	wss, wsp
BA	15-30	10YR 4/4	cl	sbk 1f	wss, wsp
2Bt1	30-60	10YR 4/6	sc	sbk 1m	wss, wsp
2Bt2	60-90	10YR 4/6	sc	sbk 2m	wss, wsp
3BC	90-120	10YR 4/5	sc	sbk 2m	wss, wsp
3C	120-150	10YR 4/5	scl	sbk 1f	wss, wsp

soil development resulting in accumulation of ferric oxide in the soil matrix. The soils of P4 were olive brown (2.5Y 4/3) in the surface and dark olive brown (2.5Y 3/2) in the subsurface horizon. Yellower hue and lower chroma in the soils of P4 may be attributed to chloritic parent material as well as seasonal hydromorphic conditions. The colour of the surface horizon was relatively darker as compared to surface horizons. This may be due to more organic matter content that imparts darkish colouration to the surface horizons.

The soil texture varied from sandy clay loam (P1, P2, P3, P5) to clay loam (P4, P6) in the surface horizon. In the control section the soils were fine loamy in P1, P3, P4, P5: moderately fine in P6 and fine in P2. The finer texture in P2 may be attributed to argillaceous parent material. The structure of the soil was mainly granular in the surface horizon and weak to moderate, fine to medium subangular blocky in the subsurface horizon. Wet consistence of the soil varied from slightly sticky to sticky and slightly plastic to plastic. Lithological discontinuity on the basis of sand/silt ratio (Sidhu *et al.* 1976) was observed in the soils of P1, P3, P4 and P6. Wide sand/silt ratios of these soils indicates stratigraphic nature of the parent materials.

Physical and chemical properties

Particle size distribution (Table 2) showed dominance of sand fractions (27.5 to 71.1 per cent). In general, sand content increased with soil depth in all the soils except in P2, where sand content was the highest in surface horizon. The silt and clay content of the soils varied from 6.0 to 29.3 per cent and 22.9 to 52.5 per cent, respectively. The clay content was maximum (32.5 to 52.5 per cent) in the soils of P2 (Kaying) developed from argillaceous parent material. Similar influence of parent material on the clay content of soil was also observed by Walia and Chamuah (1997). The significant negative correlation observed between silt and sand (r= -0.633) and between clay and sand (r= -0.674) suggests formation of silt and clay from weathering of sand in these soils (Chakravarty 1997).

The pH of the soils was acidic (3.1 to 5.7). The pH, by and large, was found to be low in the surface horizons which may be due to more organic matter content as well as more biochemical weathering and leaching of exchangeable bases down the profile under high rainfall condition. Relatively higher pH in the soils of P3 and P4 may be attributed to their parent material which contains appreciable amount of basic cations (Table 1).

The organic carbon content of the soil ranged from 0.34 to 2.06 per cent. The amount of organic carbon was higher in surface horizons of all profiles and it decreased regularly with soil depth. This may be due to accumulation of leaf litters to the surface horizon.

Loss on ignition (LOI) varied from 2.0 to 18.3 per cent. Higher LOI in the surface horizon of all the pedons was mainly related to organic matter content as corroborated by significant positive correlation (r= 0.656**) between LOI and organic matter. Spain *et al* (1982) reported that LOI was a useful index of organic matter status related to organic carbon level.

The CEC of the soil ranged from 8.9 to 27.0 cmol (p+) kg^{-1} and its gradual decrease with soil depth indicates that the CEC is mainly related to organic matter content rather than clay content of the soil. This is also supported by a significant positive correlation (r = 0.54**) between CEC and organic matter.

The per cent base saturation of the soils was low (7.6 to 41.2 per cent). This might be due to acidic parent material and leaching of bases released during weathering under the high rainfall condition.

Soil classification

From the morphological, physical and chemical characteristics of the soils, it is seen that the soils are at different stages of development. The soils have ochric epipedon in all the profiles. Higher clay content observed in the endopedons of P1, P3 and P5 did

Table 2. Physical and chemical characteristics of the soils

Horizon	Particle size distribution (%)				pH 1:2.5 Soil:Water	Organic matter (%)	Loss on ignition (%)	CEC	Sum of bases	Per cent Base Saturation
	Sand (50-200 μ)	Silt (2-50 μ)	Clay (<2 μ)	S/Si				cmol (p+) kg^{-1}		
P1 (Yachuli) Typic Dystrochrepts										
Ap	46.4	23.9	27.7	1.9	4.5	1.81	10.5	21.0	4.54	21.6
Bw1	49.1	22.3	28.6	2.2	4.8	1.03	6.1	16.7	2.42	14.5
Bw2	52.1	14.8	33.1	3.5	4.6	0.77	6.0	12.4	2.02	16.3
2Bw3	59.6	8.4	32.0	7.1	5.3	0.71	6.7	9.9	2.56	25.9
2Bw4	60.0	7.5	32.5	8.0	5.4	0.62	4.9	9.4	3.64	38.7
P2 (Kaying) Typic Paleudults										
Ap	45.0	22.5	32.5	2.0	4.8	1.18	6.7	18.4	3.00	16.3
Bt1	43.5	14.0	42.5	3.0	4.9	1.00	5.1	14.6	2.25	15.4
Bt2	34.5	17.4	48.0	2.0	4.7	0.83	4.6	13.8	1.93	14.0
Bt3	27.5	20.0	52.5	1.4	4.9	0.52	3.4	13.2	1.48	11.2
Bt4	37.5	15.0	47.5	2.5	5.1	0.41	3.3	13.2	2.23	17.3
P3 (Mon) Typic Dystrochrepts										
Ap	52.5	22.8	25.0	2.3	5.1	1.44	13.2	23.0	6.99	30.4
Bw1	52.0	21.8	26.2	2.4	5.5	0.80	10.6	20.5	3.38	16.5
Bw2	50.9	22.1	27.0	2.3	5.4	0.56	8.0	19.6	2.82	14.4
2Bw3	58.0	9.5	32.5	6.1	5.7	0.46	7.2	17.0	3.69	21.7
2Bw4	65.0	10.0	25.0	6.5	5.7	0.34	6.6	13.8	3.53	25.6
P4 (Roing) Aeric Endoaquults										
Ap	45.0	27.5	27.5	1.6	5.6	1.34	5.0	14.8	6.10	41.2
Bt1	42.8	21.8	35.4	2.0	5.6	1.13	4.7	13.0	4.00	30.8
2Bt2	54.1	7.5	38.4	7.2	5.5	1.02	3.2	10.6	2.63	24.8
2Bt3	54.0	11.0	35.0	4.9	5.2	0.46	2.1	9.6	2.68	27.9
3C	71.1	6.0	22.9	11.8	4.8	0.46	2.0	8.9	1.76	19.8
P5 (Bordumsa) Umbric Dystrochrepts										
Ap	45.0	22.5	32.5	2.0	4.3	2.06	18.3	19.0	4.60	24.2
BA	48.0	16.8	35.2	2.8	4.6	1.08	9.8	15.0	4.11	27.4
Bw1	45.6	18.4	36.0	2.5	4.1	0.59	4.2	15.0	3.37	22.5
Bw2	38.4	26.1	35.5	1.5	4.5	0.45	5.1	16.0	3.33	20.8
C	50.0	22.5	27.5	2.2	3.8	0.36	3.6	14.6	3.91	26.8
P6 (Tupi) Ruptic-Ultic Dystrochrepts										
Ap	43.0	27.0	30.0	1.6	4.7	1.29	16.0	27.0	2.05	7.6
BA	37.0	29.3	33.7	1.3	4.8	0.93	11.8	23.0	1.89	8.2
2Bt1	46.4	13.1	40.5	3.5	4.6	0.67	8.5	17.0	1.95	11.5
2Bt2	49.7	10.6	39.7	4.7	4.7	0.56	8.1	14.4	2.72	18.9
3BC	46.0	18.9	35.1	2.4	4.7	0.51	8.0	12.0	2.15	17.9
3C	53.0	15.0	32.0	3.5	4.9	0.36	5.2	13.6	2.13	15.7

not meet the requirement for argillic horizon. So these horizons qualified for cambic 'B' horizon. The low base saturation (<60%) indicated dystric characteristics in P1, P3 and P5. So these soils were classified under Dystrochrepts. The Ap horizon of P5 had colour value (moist) of 3. So the soils of P5 belonged to 'umbric' subgroup. The subsurface horizon of P2, P4 and P6 had clay enrichment and met the requirement for argillic horizon. These soils were developed from aridic parent materials and the per cent base saturation of the soils was low throughout the profile. But the thickness of the argillic horizon of P6 was less than half of the pedon. So the soils of P6 qualified for Dystrochrepts with 'Ruptic-Ultic' subgroup. In the soils of P2 the clay decrease was less than 20 per cent from the maximum clay content with increasing soil depth. The soils of P2 qualified for Typic Paleudults. The soils of P4 had reduced matrix with a hue of 2.5Y throughout the profile and low chroma (2) below a depth of 30 cm. These soils qualified for Endoaquults with 'Aeric' subgroup. The studied soils were classified (Soil Survey Staff 1994) as below:

P1 (Yachuli)	:	Typic Dystrochrepts
P2 (Kaying)	:	Typic Paleudults
P3 (Mon)	:	Typic Dystrochrepts
P4 (Roing)	:	Aeric Endoaquults
P5 (Bordumsa)	:	Umbric Dystrochrepts
P6 (Tupi)	:	Ruptic-Ultic Dystrochrepts

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