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Characteristics and classification of some acid soils of Lower Subansiri district of Arunachal Pradesh

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Abstract

Five typical pedons representing different altitudes and supporting different vegetations in Lower Subansiri district of Arunachal Pradesh were studied to characterise, classify and to investigate the effect of vegetation on the development of soil acidity. The soils, in general, are deep, well to somewhat excessively drained, acidic, variable in texture, high in organic matter and are low base saturated. The surface layer of the pine growing soils are relatively more acidic, rich in organic carbon, low base saturated, higher total potential acidity and pH dependent acidity than that of non-pine forest soils. Both pine and non-pine forest soils are high in exchangeable acidity as well as exchangeable Al^{+3} in subsoils. The soils were grouped into Inceptisols and Ultisols due to the presence of cambic and argillic horizons and were classified as Typic Haplohumults, Humic Pachic Dystrudepts, Typic Kanhaplohumults, Typic Palehumults and Humic Dystrudepts at sub-group level.

Additional keywords : Pine forest, potential acidity, exchangeable acidity, pH dependent acidity

Introduction

Vegetation cover by higher plants influence the soil in a number of ways, principally through the addition of organic matter, action of roots in binding soil particles and amelioration of climatic conditions at the soil surface (Fitzpatrick 1986). Thus the morphology of the soil horizons is affected by the nature of organic matter added to the soil and also the addition of water soluble compounds from leaves or decaying litter to the soil solution which influences the translocation of mineral substances during leaching process (Davies 1971).

In India, several studies on relationship betwen soil properties and the vegetation changes have been carried out (Singh *et al.* 1985; Banerjee *et al.* 1986; Gangopadhyay and Banerjee 1987). Pine, a coniferous species, usually found in the medium to high altitude of hills has been introduced in the hill region of intermediate elevation of north-eastern region. It is growing well in the region with luxuriant vegetative growth, which may influence the soil properties through the addition of leaf and litter-fall. However, the information regarding the pine growing soils of Arunachal Pradesh is very meager. Keeping this in view, the study was undertaken to characterise and classify the soils under pine forest and mixed natural forest in Lower Subansiri district of Arunachal Pradesh and also to bring out the comparative effect of these species on soil properties.

Materials and methods

Study area : The study area lies between 27°10'35" to 27°37'05" N latitudes and 93°36' to 93°55'30" E longitudes covering an area of about 1500 sq. km in Ziro and Kimin circles of the Lower Subansiri district, Arunachal Pradesh. Geologically, the area consists of granite gneiss (Bomdilla group) and sandstone and is mainly drained by the Subansiri river. The climate is humid subtropical. The mean annual air temperature is 17.5°C and mean summer and mean winter temperatures are 20.7° and 11.2°C, respectively. The area qualifies for '*thermic*' soil temperature regime. The mean annual rainfall ranges from 2000 mm to 2540 mm, which is mostly distributed from March to September. The soil moisture regime is '*udic*'.

The natural vegetation comprises mainly of sub-tropical evergreen forests with planted pine trees (*Pinus roxburghii*). The other dominant plant species are *Grmelina arborea* (Gamari), *Canarium resiniform* (Dhuna), *Toona ciliata* (Jatipoma), *Duabanga grandiflora* (Khokan), *Terminalia chebula* (Hillika), and *Bambusa balaca* (Bamboo).

During the field survey work (1:250,000 scale) for the preparation of soil resource map of the state, five representative pedons representing the dominant and sub-dominant soils of various physiographic units were collected from different locations of Lower Subansiri district of Arunachal Pradesh. These soils occurred at an elevaton ranging from 910 to 1750 m above MSL supporting different types of vegetation. Out of these five, the pedons collected from Linia (P1), Tarin (P2) and upper Yachuli (P3) represent the pine growing soils and the other two pedons collected from Padi (P4) and lower Tago (P5) represent the natural mixed forest vegetation. The site characteristics of the pedons comprising of location, landform, parent material and land use are presented in table 1

The morphometric properties of the soils were studied as per the procedure outlined in Soil Survey Manual (Soil Survey Staff 1951) and the physical and chemical characteristics of the soil samples (<2 mm) were determined for particle size analysis, pH, organic carbon, CEC, exchangeable bases and base saturation following standard procedures (Black 1965). Total potential acidity was determined by $BaCl_2$-triethanolamine buffered at pH 8.0 (Peech *et al.* 1962).

Table 1. Site characteristics of soils

Pedon	Village	Location	Elevation (m)	Slope (%)	Drainage	Topography	Erosion	Parent material	Land Use
P1	Linia	27°37'05" N 93°49'39"	1750	15-30	Well	Top slope of hills	Moderate	Sandstone	Moderately dense pine forest
P2	Tarin	27°31'14" N 93°51'45" E	1550	15-30	Well	Lower hill slope	Moderate	Colluvium & Sandstone	Moderately dense pine forest
P3	Upper Yachuli	27°27'58" N 93°45'36" E	1150	8-15	Well	Moderately dissected hills	Moderate	Gneiss and Schist	Pine forest
P4	Padi	27°01'35" N 93° 55' 30" E	900	15-30	Somewhat excessively	Middle slope of hills	Moderate	Gneiss	Mixed natural forest
P5	Lower Tago	27°26'03" N 93°44'33" E	1100	15-30	Somewhat excessively	Upper slope hills	Severe	Gneiss	Mixed natural forest

Exchangeable acidity and exchangeable Al^{+3} was determined by leaching the soil with unbuffered 1(*N*) KCl solution (Black 1965). Acidity due to variable charge (pH dependent) was computed by difference between total potential acidity and exchangeable acidity. CEC of clay was calculated as described by Sys *et al.* (1991) using the formula : CEC of clay = (CEC of soil - K x % organic matter)/percentage of clay, where K=1.5 cmol (p+) kg^{-1} for tropical and sub-tropical soils. The soils were classified as per Keys of Soil Taxonomy (Soil Survey Staff 1998).

Results and discussion

Morphological properties : The morphological characteristics of these soils are presented in table 2. The soils are deep, well to somewhat excessively drained with variable texture. The colour of the surface layer varies from dark brown to very dark grayish brown and the subsurface soil colour varies from dark yellowish brown to strong brown except in the pedon 3 and 4 where the colour varies from brown to red. The dark colour of surface soils may be due to high amount of organic matter at the surface and yellowish brown and reddish colour in subsurface soils due to formation of non-hydrated iron oxide under excessively drained and heavy rainfall conditions (Gerrad 1981). There is no distinct effect of vegetation on colour variation of the soils.

The soils representing pedon 1 and 2 are fine silty to fine loamy in control section whereas the soils of pedon 3 and 4 are fine textured. The texture in control section of pedon 5 is sandy clay loam to sandy loam with appreciable amount of gravels and stones. The variations in texture of the soils are mainly due to the differences in composition of parent materials.

Table 2. Morphological characteristics of soils

Horizon	Depth (m)	Colour	Texture (moist)	Coarse fragments (vol %)	Structure	Consistency (wet)	Cutans
P_1 : Fine-slity, mixed, thermic Typic Haplohummults							
A	0-0.14	10 YR 3/3	sil	-	f1gr	ss,ps	-
AB	0.14-0.30	10 YR 4/6	sil	-	m2sbk	ss, ps	-
Bt1	0.30-0.56	10 YR 5/8	sicl	-	m2sbk	s, p	T tn p
Bt2	0.56-0.84	10 YR 5/6	sicl	5	m2sbk	s, p	T tn p
Bt3	0.84-1.15	7.5 YR 4/6	sicl	10	c2sbk	s,p	T tn p
BC	1.15-1.50	7.5 YR 4/6	sil	-	m	ss,ps	-
C	1.50-1.85	7.5 YR 4/6	sil	-	m	ss, ps	-
P_2 : Fine-loamy, mixed, thermic Humic Pachic Dystrudepts							
A	0-0.17	10 YR 3/2	cl	-	f2gr	s,p	-
Bw1	0.17-0.35	10 YR 3/3	cl	-	m2sbk	s,p	-
Bw2	0.35-0.60	10 YR 3/3	cl	15	m2sbk	s,p	-
Bw3	0.60-0.83	10 YR 4/4	cl	20	m2sbk	s,p	-
BC	0.83-1.25	10 YR 5/4	cl	-	m2sbk	s,p	-
C	1.25-1.65	10 YR 5/3	sl	-	m	ss,ps	-
P_3 : Fine, mixed, thermic Typic Kanhaplohumults							
A	0-0.19	10 YR 3/2	cl	-	f2gr	ss,ps	-
Bt1	0.19-0.42	10 YR 4/3	c	-	m2sbk	s,p	T tn p
Bt2	0.42-0.75	5 YR 4/6	c	-	m3sbk	s,p	T tn p
Bt3	0.75-1.07	2.5 YR 4/6	c	-	m2sbk	s,p	T tn p
Bt4	1.07-1.40	2.5 YR 4/6	c	-	m2sbk	s,p	-
BC	1.40-1.85	2.5 YR 4/6	scl	-	f1sbk	s,p	-
P_4 : Fine, mixed, thermic Typic Palehumults							
A	0-0.18	10 YR 3/2	scl	-	f1gr	ss,ps	-
Bt1	0.18-0.36	10 YR 4/4	cl	-	m1sbk	s,p	-
Bt2	0.36-0.50	7.5 YR 4/4	cl	-	m2sbk	s,p	T tn p
Bt3	0.50-0.74	5 YR 4/6	c	-	m2sbk	vs,sp	T tn p
Bt4	0.74-1.00	5 YR 5/8	c	-	m2sbk	vs,vp	T tn p
Bt5	1.00-1.50	5 YR 5/8	c	-	m2sbk	vs,vp	T tn p
BC	1.50-1.85	2.5 YR 4/8	c	-	m2sbk	s,p	-
P_5 : Loamy-skeletal, mixed, thermic Humic Dystrudepts							
A	0-0.15	10 YR 3/2	scl	10	m2sbk	s,p	-
Bw1	0.15-0.31	10 YR 4/4	scl	30	m2sbk	s,p	-
Bw2	0.31-0.63	10 YR 4/4	scl	50	m1sbk	s,p	-
Bw3	0.63-1.04	10 YR 5/4	scl	60	m1sbk	s,p	-
BC	1.04-1.42	10 YR 6/4	sl	70	m	ss,ps	-
C	1.42-1.67	10 YR 6/4	sl	75	m	ss,ps	-

Note : Abbreviations used as per Soil Survey Staff (1951)

The structure of surface soil of most of the pedons is granular due to the presence of high amount of organic matter. However, the structure of the subsurface soils are sub-angular blocky in all the pedons and sometimes it is massive in lower horizons. Thin patchy clay cutans were noticed in the soils of pedon 1, 3 and 4 indicating the formation of argillic subsurface diagnostic horizon. The coarse fragments mainly gravels are present in the sub-surface soils of pedon 1 and 2 whereas it occurs throughout the pedon of Lower Tago (P5).

Physical and chemical properties : The physical and chemical characteristics of the soils (Table 3) show that all the soils are acidic in reaction and the pH of these soils varies from 4.7 to 5.6. The slight variation of pH with depth may be due to intensive weathering and subsequent leaching of bases in sloping landforms. The pH of the surface layer of pine growing soils (P1, P2 and P3) is more acidic in comparison to non-pine growing (P4 and P5) soils. In all the cases, pH (KCl) is lower than that of pH (H_2O) indicating that all the soils under natural pH conditions carry a net negative charge and contain considerable amount of reserve acidity (Brady 1984; Bleeker and Sageman 1990). The low pH in these soils is mainly due to acidic parent materials, leaching of bases and presence of appreciable amount of exchangeable Al^{+3}. The exchangeable Al^{+3} content of these soils varies from trace to 5.0 cmol (p+) kg^{-1} (Table 4). Relatively low amount of exchangeable Al^{+3} in the surface soil appears to be due to mobilisation of Al^{+3} by its complexes with organic acids produced by decomposition of leaf-litter in surface horizon and subsequently, the downward movement and adsorption of these complexes by clay minerals in the subsurface horizons (Schnitzer and Skinner 1963).

The organic carbon content in the surface soils ranges from 25.0 to 64.1g kg^{-1} and it decreases abruptly with depth. The higher organic carbon content of the surface layer is observed in the soils under *Pinus* species (P1 and P2), which may be due to slow mineralization of organic matter by low temperature and high rainfall at higher altitudes. The relatively low value of organic carbon in the surface layer of the non-pine soils is mainly due to lesser accumulation of leaves and litters beneath the tree in comparison to that of *Pinus* species.

The clay content of the soils ranges from 14.0 to 57.0 per cent and it usually increases in subsoils, which decreases again in lower horizons in most of the soils. The clay increase in Bt horizons by 1.2 times than overlying layers of pedons 1, 3 and 4 confirm the presence of argillic horizons which was also indicated by morphological study. The CEC of the surface soils varies from 11.9 to 25. 2 cmol (p+) kg^{-1} and it decreases with depth as the organic matter and clay content decrease downward (Table 4). The CEC of the subsoils in P3 and P4 is low in comparison to clay content indicating the presence of low activity clay minerals (Bhattacharyya *et al.* 1994). The higher CEC value in the surface layer is mainly contributed by organic

Table 3. Physical and chemical characteristics of soils

Horizon	Depth (m)	Sand (%)	Silt (%)	Clay (%)	pH H_2O	pH KCl	Org. C (g kg^{-1})
P1 : Fine-silty, mixed, thermic Typic Haplohumults							
A	0-0.14	26.0	53.5	20.5	4.9	3.8	64.1
AB	0.14-0.30	24.2	53.8	22.0	5.1	4.2	44.1
Bt1	0.30-0.56	12.8	57.7	29.5	5.1	4.2	10.5
Bt2	0.56-0.84	12.2	50.3	37.5	5.0	4.0	3.8
Bt3	0.84-1.15	15.9	45.9	38.0	4.7	3.7	2.7
BC	1.15-1.50	15.9	59.1	25.0	5.0	3.7	2.7
C	1.50-1.85	17.3	58.6	24.1	4.9	3.7	2.2
P2 : Fine-loamy, mixed, thermic Humic Pachic Dystrudepts							
A	0-0.17	36.5	29.5	34.0	5.1	4.1	54.7
Bw1	0.17-0.35	34.2	30.3	35.5	4.8	4.0	27.4
Bw2	0.35-0.60	37.1	29.9	33.0	4.8	4.0	13.3
Bw3	0.60-0.83	36.2	32.5	31.3	5.2	3.9	5.7
BC	0.83-1.25	35.8	34.7	29.5	5.1	3.9	4.1
C	1.25-1.65	58.9	21.6	19.5	5.0	3.9	2.5
P3 : Fine, mixed, thermic Typic Kanhaplohumults							
A	0-0.19	35.6	28.4	36.0	5.3	4.2	36.4
Bt1	0.19-0.42	34.5	22.5	43.0	4.9	3.8	22.6
Bt2	0.42-0.75	30.6	20.9	48.5	4.9	3.8	9.8
Bt3	0.75-1.07	25.2	17.8	57.0	5.2	3.9	5.6
Bt4	1.07-1.40	29.7	17.3	53.0	5.2	4.1	2.8
BC	1.40-1.85	53.3	13.7	33.0	5.6	4.3	0.8
P4 : Fine, mixed, thermic Typic Palehumults							
A	0-0.18	50.1	24.4	25.5	5.4	4.4	28.0
Bt1	0.18-0.36	40.2	28.8	31.0	5.0	3.8	15.8
Bt2	0.36-0.50	42.9	23.1	34.0	4.9	3.8	8.0
Bt3	0.50-0.74	34.3	20.7	45.0	5.0	3.7	5.7
Bt4	0.74-1.00	35.0	22.0	43.0	5.0	3.7	5.2
Bt5	1.00-1.50	34.9	21.1	44.0	5.0	3.6	3.6
BC	1.50-1.85	36.5	21.5	42.0	4.8	3.6	3.3
P5 : Loamy-skeletal, mixed, thermic Humic Dystrudepts							
A	0-0.15	58.7	14.8	26.5	5.5	4.3	25.0
Bw1	0.15-0.31	57.1	11.4	31.5	5.0	3.8	10.3
Bw2	0.31-0.63	55.6	11.4	33.0	5.1	3.8	2.7
Bw3	0.63-1.04	64.9	10.6	24.5	5.1	3.9	1.1
BC	1.04-1.42	63.7	12.3	19.0	5.4	4.0	0.4
C	1.42-1.67	74.9	11.1	14.0	5.3	4.0	0.4

Table 4. Exchange properties and forms of soil acidity

Depth (m)	CEC (soils)	H+	Al^{+3}	Base Saturation	CEC (clay)	Total Potential acidity	Exchange acidity		pH dependent acidity	
	--- cmol (p^+) kg^{-1} ----				----cmol(p^+) kg^{-1}----					
P1 : Fine-silty, mixed, thermic Typic Haplohumults										
0-0.14	25.2	1.2	0.2	17	41.9	41.6	1.4	(3.4)	40.2	(96.6)
0.14-0.30	20.6	1.3	1.1	13	41.8	30.8	2.2	(7.8)	28.4	(92.2)
0.30-0.56	11.9	1.1	1.0	12	31.1	20.8	2.1	(10.1)	18.7	(89.9)
0.56-0.84	10.4	0.4	2.7	13	25.1	16.0	3.1	(19.4)	12.9	(80.6)
0.84-1.15	10.4	0.3	2.7	10	25.5	15.2	3.0	(19.7)	12.2	(80.3)
1.15-1.50	8.2	0.4	3.0	13	30.0	13.6	3.4	(25.0)	10.2	(75.0)
1.50-1.85	7.8	0.3	3.1	12	29.8	13.7	3.4	(24.8)	10.3	(75.2)
P2 : Fine-loamy, mixed, thermic Humic Pachic Dystrudepts										
0-0.17	23.9	0.2	0.6	25	28.5	30.4	0.8	(2.6)	29.6	(97.4)
0.17-0.35	17.6	0.4	1.6	24	29.6	22.2	2.0	(3.0)	20.2	(97.0)
0.35-0.60	13.0	0.2	2.5	10	29.1	15.5	2.7	(17.7)	12.8	(82.6)
0.60-0.83	11.6	0.3	2.3	10	32.2	11.6	2.6	(22.4)	9.0	(77.6)
0.83-1.25	11.1	0.4	2.7	10	33.9	10.3	3.1	(30.1)	7.2	(69.9)
1.25-1.65	8.7	trace	3.0	13	41.5	8.5	3.0	(35.3)	5.5	(64.7)
P3 : Fine, mixed, thermic Typic Kanhaplohumults										
0-0.19	17.6	0.3	0.4	47	22.8	22.8	0.7	(3.1)	22.1	(96.9)
0.19-0.42	14.4	0.4	2.3	13	19.8	20.8	2.7	(12.9)	18.1	(87.1)
0.42-0.75	9.8	0.3	2.6	13	15.0	16.4	2.9	(17.7)	13.5	(82.3)
0.75-1.07	9.4	0.4	2.0	12	14.0	15.2	2.4	(15.8)	12.8	(84.2)
1.07-1.40	8.9	0.2	2.4	12	15.5	13.6	2.6	(19.1)	11.0	(80.9)
1.40-1.85	4.5	0.5	0.5	22	13.0	8.8	1.0	(11.4)	7.8	(88.6)
P4 : Fine, mixed, thermic Typic Palehumults										
0-0.18	14.1	0.4	trace	49	26.6	18.6	0.4	(2.1)	18.2	(97.9)
0.18-0.36	12.6	0.5	2.3	27	27.4	15.2	2.8	(18.4)	12.4	(87.6)
0.36-0.50	10.4	0.3	3.5	24	24.4	12.4	3.8	(30.6)	8.6	(69.4)
0.50-0.74	10.9	0.3	4.3	20	20.9	13.6	4.6	(33.8)	9.0	(66.2)
0.74-1.00	10.8	0.1	3.8	20	20.6	13.2	5.1	(39.2)	7.9	(60.8)
1.00-1.50	10.6	0.4	3.8	19	20.6	13.0	5.1	(39.2)	7.9	(60.8)
1.50-1.85	9.7	0.2	4.8	19	21.2	13.8	5.0	(36.2)	8.8	(63.8)
P5 : Loamy-skeletal, mixed, thermic Humic Dystrudepts										
0-0.15	11.9	0.3	0.1	37	20.4	17.8	0.4	(2.2)	17.4	(97.8)
0.15-0.31	11.2	0.2	2.4	21	27.0	14.3	2.6	(18.2)	11.7	(81.8)
0.31-0.63	10.8	0.1	2.6	18	30.6	10.9	2.7	(24.8)	8.2	(75.2)
0.63-1.04	8.6	0.1	2.4	20	33.8	8.5	2.5	(29.4)	6.0	(70.6)
1.04-1.42	5.8	0.3	1.2	24	30.0	6.7	1.5	(22.3)	5.2	(77.7)
1.42-1.67	5.4	0.2	1.3	30	37.8	6.1	1.5	(24.6)	4.6	(75.4)

The figures in parentheses indicate the percentage of total potential acidity.

matter through leaf and litter decomposition. Among the exchangeable bases, Ca^{2+} is the dominant cation followed by Mg^{2+}, Na^{+} and K^{+}. The CEC of soil clays is low to medium, which ranges from 13.0 to 41.9 cmol (p+) kg^{-1} and the minimum value was observed in Pedon 3. The base saturation of surface soils varies from 17 to 39 per cent and it is very low in subsurface soils ranging from 10 to 30 per cent. The base saturation in general is low due to preponderance of Al^{+3} and H^{+} on exchange complex and it is relatively high on surface soil suggesting thereby recycling of basic cations through vegetation (Walia and Chamuah 1996). The base saturation of pine growing soils is lower than that of non-pine soils since pine leaves and litters contain lesser amount of bases than that of broad leaved forest species (Gangopadhyay and Banerjee 1987).

Soil acidity : Total potential acidity of the surface layers of the soils varies from 17.8 to 41.6 cmol (p+) kg^{-1} and its value ranges from 6.1 to 30.8 cmol (p+) kg^{-1} in subsoils (Table 4). Though it is higher in surface soils of all pedons, the total acidity of the surface layer of the pine growing soils are higher in comparison to that of non-pine forest soils which is probably due to the high content of organic matter. Exchange acidity of these soils varies from 0.4 to 5.1 cmol (p+) kg^{-1}. The low values of exchange acidity in the surface soil is observed in all the pedons due to the removal of exchangeable Al^{+3} through chelation with organic acids into the lower horizons. The exchange acidity of the soils of Padi (P_4) is relatively higher than that of other soils, which is indicated by higher amount of exchangeable Al^{+3} in subsoils. The exchange acidity contributes 2.1 to 38.6 per cent of the total potential acidity and its value is insignificant in surface soils (2.1 to 3.4 per cent).

The acidity due to variable charge (pH dependent) of the soils varies from 4.6 to 39.4 cmol (p+) kg^{-1} and it decreases gradually downward. It is also observed that the pH dependent acidity of the surface and subsurface horizons of pine soils are relatively higher than that of non-pine forest soils, which is mainly due to the higher amount of organic matter. The pH dependent acidity covers the major share of total potential acidity, which ranges from 61.4 to 97.9 per cent.

Classification : The soils of pedons 1, 3 and 4 with argillic horizons and less than 35 per cent base saturation are classified in the order Ultisols. The presence of more than 0.9 per cent (weighted average) of organic carbon in the upper 15 cm of the argillic horizon grouped these soils as Humults at suborder level. The absence of kandic horizon and not having the percentage of clay decrease from the maximum amount by as much as 20 per cent within the required depth (150 cm) qualify the soils of pedon 4 as Palehumults at great group level. Pedon 1 is classified as Haplohumults due to the decrease of clay by more than 20 per cent from the maximum within 150 cm depth whereas the presence of kandic horizon (CEC of clay less than

16 cmol (p^+) kg^{-1} by 1*N* NH_4OAc at pH 7 in the major part of the clay enriched horizons) and decrease of clay by more than 20 per cent within 150 cm depth of pedon 3 qualifies it for Kanhaplohumults. All the soils of Pedons 1, 3 and 4 represent central concept of corresponding great groups and hence they are keyed out as Typic Haplohumults, Typic Kanhaplohumults and Typic Palehumults at subgroup level, respectively.

Soils representing Pedon 2 and 5 have textural and/or structural development indicating the formation of cambic horizon. Hence, the soils are classified in the order Inceptisols. The presence of 'udic' moisture regime classify the soil as Udepts in the suborder level and low base status (base saturation less than 60 per cent by 1*N* NH_4OAc at pH 7.0 throughout the soil between depth of 25 and 27 cm below the soil surface) of the soil keyout as Dystrudepts in the great group level. The presence of the umbric epipedon which is more than 50 cm thick qualifies the soil for Humic Pachic Dystrudepts (Pedon 2) and the other soil (Pedon 5) qualifies for Humic Dystrudepts at subgroup level. The temperature regime of the soils is 'thermic' and the mineralogy is mixed. The soils (Pedon 1 to 5) are classified at family level as follows :

Pedon 1 : Fine-silty, mixed, thermic Typic Haplohumults

Pedon 2 : Fine-loamy, mixed, thermic Humic Pachic Dystrudepts

Pedon 3 : Fine, mixed, thermic Typic Kanhaplohumults

Pedon 4 : Fine, mixed, thermic Typic Palehumults

Pedon 5 : Loamy-skeletal, mixed, thermic Humic Dystrudepts.

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