



## Characterization and Classification of Some Coastal Soils of Guntur District, Andhra Pradesh, India

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**Coastal soils (sandy and inland black soils) in the Pedapuluguvaripalem village of Guntur district, Andhra Pradesh were characterized and classified. A total of eight representative profiles were selected from different locations in the village. Soils were moderately shallow to moderately deep, poorly drained to excessively drained and brownish yellow to very dark gray in colour. They were neutral to strongly alkaline (7.0 - 9.8), low in organic carbon with wide variation in particle size distribution. The soils exhibited wide variation in CEC (3.86 to 38.64 cmol (p+) kg<sup>-1</sup> soil) and ESP (5.90 - 24.99), and were classified under Inceptisols and Entisols.**

**(Key words:** *Sandy soils, Black soils, Morphology, Inceptisols, Entisols***)**

Indian coast line covers a length of about 8129 km, of which 972 km is in Andhra Pradesh. Coastal soils play an important role in controlling the overall ecological balance of the earth. However they are highly fragile and face problems of multidimensional nature. Therefore strategic integrated technology development based on scientific knowledge of interacting features and processes is essential to augment the proper use and management of these soils. Coastal soils of Guntur district can be represented by Pedapuluguvaripalem village comprising of sandy and inland black soils. Soil testing values give a fair amount of idea about the existing fertility status indicating the state of soil health. In the present study, an attempt has been made to characterize and classify the coastal soils by studying their morphological characters and physico-chemical properties.

### MATERIALS AND METHODS

The study area, Pedapuluguvaripalem is a coastal village in Guntur district of Andhra Pradesh. It is situated between 15°95' and 16°13' North latitude and 80°65' East longitude. A total of eight representative profiles were opened in different locations and studied for their morphological characters as per Soil Survey Staff (1951). Horizon-wise soil samples were collected and analyzed for their physico-chemical properties following standard procedures (Jackson, 1973; Bower *et al.*, 1952). The soils under study were classified according to USDA soil taxonomy (Soil Survey Staff, 2006).

### RESULTS AND DISCUSSIONS

#### Climate and site characteristics

The area was confined to semi-arid to sub-humid climate with mean annual precipitation of 1007.84 mm. The mean annual maximum and minimum temperatures were 33.10°C and 23.11°C. Soil moisture and temperature regimes were Ustic and Hyperthermic, respectively. The soils were developed from geological depositions in different periods. The slope of the soils under study was less than 1 per cent with all of them falling in plain topography.

#### Morphological and physico-chemical properties

The data related to these parameters are presented in tables 1 and 2, respectively. The profile 1 was moderately deep and poorly drained with indistinct slicken sides below 0.74 m. The soils were having single grained structure at the surface and sub-angular blocky to angular blocky structure at the lower horizons. The texture varied from coarse at the surface and fine in the lower horizons. The soils were dark brown to very dark gray in colour. Differential deposition of sediments and variation in soil composition might have favoured the development of these features. The soil pH varied from neutral to strongly alkaline. The total soluble salts ranged from 0.49 to 2.00 dS m<sup>-1</sup>. The combined effect of soil forming factors particularly vegetation, parent material, climate as well as presence of high amount of exchangeable sodium and relatively high proportion of soluble salts dominated by carbonates

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**Table 1.** Summary of the morphological characteristics of the soil profiles

Profile no. and horizon	Depth (m)	Colour		Texture	Structure			Consistence			Efferv- scences	Pores		Roots		Boundary	Other features
		Dry	Moist		S	G	T	Dry	Moist	Wet		Size	Qty.	Size	Qty.		
Profile 1 Coarse loamy over clayey, smectite, iso-hyperthermic, Vertic Haplustepts																	
Ap	0.00-0.17	7.5YR 3/2	7.5YR 3/2	ls			sg	l	l	sopo	e	m	m	m	m	cs	Indistinct slickensides below 0.74m
2B	0.17- 0.33	7.5YR 3/1	7.5YR 3/1	c	m	2	sbk	vh	fi	vsvp	e	f	m	m	c	gw	
2Bw1	0.33-0.51	10YR 3/1	10YR 3/1	c	m	2	sbk	vh	fi	vsvp	e	f	m	f	f	dw	
2Bw2	0.51-0.74	10YR 4/1	10YR 3/2	c	m	2	sbk	vh	vfi	vsvp	e	vf	c	f	f	dw	
2Bw3	0.74-1.00	10YR 4/1	10YR 3/2	c	m	3	abk	vh	vfi	vsvp	e	-	-	-	-	dw	Mottles below 1m depth
2Bw4	1.00+	10YR 4/1	10YR 3/2	c	m	3	abk	vh	vfi	vsvp	e	-	-	-	-	-	
Profile 2 Coarse loamy,smectitic, iso-hyperthermic, Fluventic Haplustepts																	
Ap	0.00-0.14	10YR 6/3	10YR 4/3	ls			sg	l	l	sopo	-	c	m	m	m	cs	
A2	0.14-0.29	10YR 5/4	10YR 4/4	ls			sg	l	l	sopo	-	m	m	m	c	dw	
2Bw1	0.29-0.49	10YR 5/4	10YR 4/4	scl	m	2	sbk	sh	vfr	sp	-	f	c	f	c	gw	
2Bw2	0.49-0.72	10YR 5/4	10YR 4/4	scl	m	2	sbk	sh	vfr	sssp	-	f	f	-	-	cw	
2BC	0.72-0.96	10YR 4/4	10YR 4/3	sl	m	1	sbk	sh	vfr	sssp	-	-	-	-	-	gw	
3C	0.96+	10YR 5/8	10YR 5/4	ls			sg	l	l	sopo	-	-	-	-	-	-	
Profile 3 Coarse loamy, smectitic, iso-hyperthermic, Typic Ustipsamments																	
Ap	0.00-0.12	7.5YR 4/4	10YR 3/4	ls	-	-	sg	l	l	sopo	-	m	m	c	m	ds	
AC	0.12-0.29	10YR 4/3	10YR 3/3	ls	-	-	sg	l	l	sopo	-	f	c	m	f	ds	
C1	0.29-0.40	10YR 4/4	10YR 3/4	ls	-	-	sg	l	l	sopo	-	f	c	f	f	cw	
C2	0.40-0.67	10YR 4/6	10YR 3/6	ls	-	-	sg	l	l	sopo	-	f	f	-	-	dw	
C3	0.67+	10YR 4/6	10YR 3/6	ls	-	-	sg	l	l	sopo	-	vf	f	-	-	-	
Profile 4 Fine loamy, smectitic, isohyperthermic, Vertic Haplustepts																	
Ap	0.00-0.20	10YR 4/3	10YR 3/3	ls			sg	s	l	sopo	-	c	m	m	m	cw	
2Bw1	0.20-0.50	10YR 4/2	10YR 3/2	scl	m	2	sbk	h	fr	sp	e	m	m	m	m	dw	
2Bw2	0.50-0.71	10YR 3/2	10YR 3/2	scl	m	2	sbk	h	fr	sp	e	f	c	f	f	ds	
2Bw3	0.71-0.90	10YR 7/4	10YR 6/3	scl	m	1	sbk	l	fr	ss	e	f	f	-	-	cw	
3C1	0.90-0.96	10YR 6/4	10YR 5/4	sl			sg	l	l	sopo	-	-	-	-	-	ds	
3C2	0.96-1.10	10YR 6/3	10YR 5/3	s			sg	l	l	sopo	-	-	-	-	-	-	
Profile 5 Clayey over loamy, smectitic, iso-hyperthermic, Udifluventic Haplustepts																	
Ap	0.00-0.13	10YR4/2	10YR 3/2	c	m	3	sbk	vh	vfi	vsvp	-	m	m	m	m	gs	Redoximorphic features below 40 cm
B	0.13-0.21	10YR 4/1	10YR 3/1	sc	m	3	sbk	vh	vfi	vsvp	-	m	c	m	c	aw	
Bw1	0.21-0.45	10YR 4/1	10YR 3/1	c	m	2	abk	vh	vfi	vsvp	-	f	f	-	-	dw	
Bw2	0.45-0.63	10YR 4/1	10YR 3/1	c	m	2	abk	vh	fi	vsvp	-	-	-	-	-	ds	
2C	0.63-0.95	10YR 5/3	10YR 5/4	sl	m	1	sbk	h	fr	ss	-	-	-	-	-	cs	
3C	0.95+	10YR 5/3	10YR 5/3	s			sg	l	l	sopo	-	-	-	-	-	-	

Contd.

Profile no. and horizon	Depth (m)	Colour		Texture	Structure			Consistence			Effervescences	Pores		Roots		Boundary	Other features
		Dry	Moist		S	G	T	Dry	Moist	Wet		Size	Qty.	Size	Qty.		
Profile 6 Fine loamy over sand, smectitic, iso-hyperthermic, Typic Haplustepts																	
Ap	0.00-0.18	7.5YR 4/1	7.5YR 3/1	cl	m	2	sbk	vh	fi	vsvp	–	m	m	c	m	gs	Cracks more than 1 cm width upto depth of 50 cm
Bw1	0.18-0.34	7.5YR 4/1	7.5YR 3/1	cl	m	2	abk	vh	vfi	vsvp	–	m	c	m	c	dw	
Bw2	0.34-0.48	7.5YR 4/1	7.5YR 3/1	cl	m	2	abk	vh	vfi	vsvp	–	f	c	m	f	dw	
2C1	0.48-0.70	7.5YR 5/1	7.5YR 4/1	ls			sg	l	l	sopo	–	f	f	–	–	cw	
2C2	0.70-0.98	7.5YR 8/2	7.5YR 7/2	ls			sg	l	l	sopo	–	–	–	–	–	cw	
2C3	0.98+	10YR 7/4	10YR 7/4	s			sg	l	l	sopo	–	–	–	–	–	–	
Profile 7 Coarse loamy, smectitic, iso-hyperthermic, Typic Ustipsamments																	
Ap	0-0.13	7.5YR 5/6	7.5YR 4/6	ls	–	–	sg	l	l	sopo	–	m	m	f	m	cs	
C1	0.13-0.24	7.5YR 5/6	7.5YR 4/6	ls	–	–	sg	l	l	sopo	–	f	m	f	f	ds	
C2	0.24-0.49	10YR 5/8	10YR 5/6	ls	–	–	sg	l	l	sopo	–	f	c	vf	f	ds	
C3	0.49-0.68	10YR 5/8	10YR 5/6	ls	–	–	sg	l	l	sopo	–	–	–	–	–	ds	
C4	0.68+	10YR 6/4	10YR 5/4	s	–	–	sg	l	l	sopo	–	–	–	–	–	–	
Profile 8 Coarse loamy, smectitic, iso-hyperthermic, Typic Ustipsamments																	
Ap	0.00-0.14	10YR 5/3	10YR 4/3	sl	f	l	sbk	sh	l	ss sp	–	m	m	f	m	cw	
C1	0.14-0.22	10YR 6/6	10YR 5/6	ls	–	–	sg	l	l	sopo	–	m	c	f	f	ds	
C2	0.22-0.32	10YR 6/6	10YR 5/6	ls	–	–	sg	l	l	sopo	–	f	f	f	f	dw	
C3	0.32-0.55	10YR 6/6	10YR 5/6	ls	–	–	sg	l	l	sopo	–	vf	f	vf	f	ds	
C4	0.55-0.76	10YR 6/6	10YR 5/6	ls	–	–	sg	l	l	sopo	–	–	–	–	–	dw	
C5	0.76+	10YR 6/6	10YR 5/6	ls	–	–	sg	l	l	sopo	–	–	–	–	–	–	

Texture: c-clay ; cl-clay loam; ls- loamy sand; sl-sandy loam; sc-sandy clay; scl-sandy clay loam; s-sandy;

Structure: S-size; m-medium; c-coarse; f-fine; G-grade; 1-weak; 2-moderate; 3-strong; T-type; gr-granular; sbk-sub angular blocky; abk-angular blocky

Consistence: h-hard; sh-slightly hard; vh-very hard; l-loose; s-soft; fi-firm; vfi- very firm; fr-friable; sp-slightly plastic; vsvp-very sticky very plastic; sssp-slightly sticky slightly plastic; sopo-non sticky non plastic

Effervescence: e-slight effervescence; es-strong effervescence; ev-violent effervescence;

Pores and roots: Size: f-fine; vf-very fine; m-medium; c-coarse; Qty: f-few;vf-very few; c-common; m-many;

Boundary: c-clear; s-smooth; d-diffuse; g-gradual; w-wavy; a-abrupt; i-irregular;

and bicarbonates might have resulted in variation in soil pH and EC. The CEC increased with depth and clay content. The organic carbon content was higher at surface which gradually decreased down the depth. Calcium carbonate content was found to be very low. ESP values were high indicating sodicity which might be due to accumulation of carbonates and bicarbonates of sodium due to their presence near the brackish aqua ponds.

Profile 2 and 4 were moderately deep and moderately well drained. The soils were having single grained structure at the surface and lower horizons, while the middle horizons exhibited sub-angular blocky structure. Variable texture from coarse to fine was observed within the profile indicating geological formation. The soils were pale brown to very dark grayish brown in colour. The surface horizons exhibited neutral reaction, while the subsurface horizons exhibited alkaline to strongly alkaline reaction with pH values ranging from 7.5 to 9.9. Electrical conductivity varied from 0.41 to 8.12 dS m<sup>-1</sup>. The organic carbon content was higher at surface which gradually decreased down the depth. The CEC varied from 4.20 to 21.17 cmol (p+) kg<sup>-1</sup> soil. Profile 2 recorded higher ESP values.

Profiles 3 and 7 were moderately shallow and excessively drained. The soils were single grained throughout the depth. The soils exhibited coarse texture and were dark brown to yellowish brown in colour. Soil reaction ranged from alkaline to strongly alkaline with pH values between 7.8 and 9.1. The electrical conductivity increased down the depth which might be due to leaching down of salts from the surface. Both the profiles showed higher organic carbon content at surface which gradually decreased down the depth. The CEC varied from 3.86 to 5.98 cmol (p+) kg<sup>-1</sup> soil.

Profiles 5 and 6 were moderately deep and poorly drained. Variable texture with fine at the upper horizons and coarse at the lower horizons were observed. Soil colour varied from very pale brown to very dark gray. The structure differed from sub-angular blocky to angular blocky at the upper layers and single grained at the lower layers. Soil pH varied from 7.1 to 8.8. The soils exhibited a wide variation in total soluble salt content from 1.38 to 19.25 dS m<sup>-1</sup>. The organic carbon content was high at the surface which might be due to addition of organic residues. Profile 5 showed irregular decrease in organic carbon, while gradual decrease was

observed in profile 6. Highest value of CEC was recorded in profile 5 due to high content of clay. The soils exhibited a wide range of CEC ranging from 3.91 to 38.64 cmol (p+)kg<sup>-1</sup>.

Profile 8 was moderately deep and excessively drained. Soils were coarse textured throughout the depth. Weakly developed structure was observed in the surface horizons, while lower layers were single grained. Soils were brown to brownish yellow in colour. Soil pH varied from 8.2 to 9.4. The soils exhibited a low concentration in total soluble salt content from 0.32 to 1.18 dS m<sup>-1</sup>. The organic carbon varied from 0.5 to 3.0 g kg<sup>-1</sup>. CEC ranged from 4.35 to 10.59 cmol (p+) kg<sup>-1</sup> soil. The percent base saturation values of all the profiles were above 60. Seshagirao *et al.*, (2004) observed similar variations in morphological and physico-chemical properties of coastal soils of Prakasam district, Andhra Pradesh.

#### Soil classification

Profiles 1 and 4 had cambic horizon with its upper boundary within 100 cm of the mineral surface and its lower boundary at a depth of 25 cm or more below the mineral soil. Per cent base saturation was more than 60 per cent in all horizons and a linear extensibility of more than 6 cm between the mineral soil surface and a depth of 100 cm was observed. The soils had ustic soil moisture regime. Based on these features the soils were classified under Vertic Haplustepts at sub group level (Table 3).

In profiles 2 the soils had no frigid, hyperthermic or mesic soil temperature regime, lithic contact, coarse fragments, saturated layer within 100 cm of the mineral soil surface, lacked LE less than 6 cm and had an irregular decrease in organic carbon due to fluventic action. Hence, the profile was classified under Fluventic Haplustepts. Profile 5 showed similar features along with redox depletions within 100 cm and hence was grouped under Udifluventic Haplustepts. Profile 6 showed similar features as profile 5 except that there was regular decrease in organic carbon. Hence the profile was classified under Typic Haplustepts.

Profiles 3, 7 and 8 exhibited low organic carbon, which decreased regularly with depth. The soils lacked diagnostic horizons indicating poor profile development, lithic, paralithic contact within 25 cm of the soil surface, but had texture coarser than loamy fine sand and ustic moisture regime. Hence the profiles were classified as Typic Ustipsamments.

**Table 2.** Physico-chemical properties of the soils

Profile No. & horizon	Depth (m)	Sand	Silt (%)	Clay	pH	EC (dS m <sup>-1</sup> )	O.C. g kg <sup>-1</sup>	CaCO <sub>3</sub> (%)	CEC cmol (p+)kg <sup>-1</sup>	CEC/clay	PBS	ESP
					(1:2.5 soil: water)							
Profile – 1												
Ap	0.00-0.17	87.34	5.08	7.64	7.3	0.49	4.2	-	6.10	0.80	93.47	12.32
2B	0.17-0.33	52.30	11.20	36.50	9.3	1.61	2.9	0.3	29.45	0.69	97.96	24.97
2Bw1	0.33-0.51	51.59	12.20	36.30	9.5	2.00	2.3	0.3	31.20	0.86	98.55	24.95
2Bw2	0.51-0.74	50.40	12.40	37.20	9.6	2.00	2.3	0.5	30.61	0.71	99.51	22.80
2Bw3	0.74-1.00	41.06	13.56	42.80	9.6	1.68	2.0	0.4	33.60	0.79	99.38	24.98
2Bw4	1.00+	40.58	15.60	43.82	9.6	1.68	1.5	2.1	34.80	0.79	99.67	24.99
Profile – 2												
Ap	0.00-0.14	82.31	8.40	9.29	7.5	0.41	3.3	-	6.51	0.70	92.78	12.44
A2	0.14-0.29	80.51	8.01	11.49	9.1	0.64	1.1	-	7.82	0.68	92.98	21.88
2Bw1	0.29-0.49	66.32	9.18	24.50	9.4	1.66	1.6	-	18.15	0.74	96.61	24.10
2Bw2	0.49-0.72	68.82	9.68	21.50	9.9	1.96	0.8	-	16.25	0.76	97.67	24.99
2BC	0.72-0.96	71.26	10.32	18.42	9.9	1.60	3.0	-	13.08	0.71	98.14	25.12
3C	0.96+	85.74	4.05	10.20	9.9	0.97	1.8	-	4.20	0.41	97.38	7.38
Profile – 3												
Ap	0.00-0.12	83.05	10.06	6.89	7.8	0.54	5.9	-	3.86	0.56	96.47	10.20
AC	0.12-0.29	81.09	11.40	7.50	8.1	2.88	2.3	-	4.35	0.58	98.25	12.50
C1	0.29-0.40	80.70	10.10	9.20	7.9	3.56	2.0	-	5.44	0.59	91.76	11.80
C2	0.40-0.67	80.30	10.60	9.10	8.1	3.44	1.7	-	5.80	0.64	95.20	12.44
C3	0.67+	82.20	9.70	8.10	8.1	3.54	1.5	-	4.70	0.58	93.81	12.96
Profile 4												
Ap	0.00-0.20	85.98	5.92	8.10	7.8	0.43	2.7	-	5.20	0.64	92.29	12.10
2Bw1	0.20-0.50	54.03	20.40	25.57	8.9	4.93	1.5	1.2	18.60	0.76	92.11	18.70
2Bw2	0.50-0.71	54.17	17.14	28.23	8.7	8.12	1.7	1.1	21.17	0.75	95.89	18.90
2Bw3	0.71-0.90	56.25	16.25	27.42	8.7	6.71	1.4	0.5	20.02	0.73	95.44	18.20
3C1	0.90-0.96	78.20	11.60	10.20	8.7	6.89	0.8	0.1	7.24	0.71	97.21	6.35
3C2	0.96-1.10	76.50	14.30	9.20	8.9	8.07	0.8	-	6.44	0.70	98.60	5.90

Contd.

Profile No. & horizon	Depth (m)	Sand	Silt (%)	Clay	pH	EC (dS m <sup>-1</sup> )	O.C. g kg <sup>-1</sup>	CaCO <sub>3</sub> (%)	CEC cmol (p+)kg <sup>-1</sup>	CEC/clay	PBS	ESP
					(1:2.5 soil: water)							
Profile – 5												
Ap	0.00-0.13	44.40	12.80	42.80	8.0	19.25	6.3	-	34.24	0.80	98.57	14.40
B	0.13-0.21	46.20	8.30	45.50	8.2	14.60	4.2	-	38.64	0.85	95.94	14.70
Bw1	0.21-0.45	45.02	12.18	42.80	7.9	18.85	4.8	-	34.44	0.80	99.42	11.93
Bw2	0.45-0.63	40.58	18.80	40.62	7.1	18.62	5.3	-	33.65	0.83	99.18	10.23
2C	0.63-0.95	77.40	8.40	14.20	8.0	13.24	2.4	-	9.94	0.70	92.08	14.11
3C	0.95+	88.60	3.20	8.20	8.2	13.34	1.4	-	4.18	0.51	97.92	14.95
Profile – 6												
Ap	0.00-0.18	47.90	18.12	33.98	7.3	4.80	6.5	-	27.00	0.79	98.86	11.61
Bw1	0.18-0.34	40.70	24.80	34.50	8.6	4.92	3.6	-	26.22	0.76	99.61	16.20
Bw2	0.34-0.48	41.90	24.70	33.40	8.7	6.15	3.0	-	26.05	0.78	99.35	16.48
2C1	0.48-0.70	80.42	10.05	9.05	8.3	5.12	1.4	-	5.79	0.64	95.65	14.68
2C2	0.70-0.98	86.20	5.60	8.20	8.8	1.38	1.2	-	5.17	0.63	98.21	16.52
2C3	0.98+	89.60	4.10	6.30	8.1	5.40	0.8	-	3.91	0.62	89.45	14.69
Profile – 7												
Ap	0.00-0.13	79.90	11.05	9.04	8.8	0.61	3.3	-	5.30	0.59	93.39	20.37
C1	0.13-0.24	79.12	11.80	9.08	9.1	1.28	1.4	-	5.45	0.60	95.41	20.18
C2	0.24-0.49	78.20	12.60	9.20	9.1	2.99	1.2	-	5.98	0.65	94.64	20.06
C3	0.49-0.68	77.60	13.50	8.60	8.6	2.78	0.8	-	5.68	0.66	92.07	16.19
C4	0.68+	84.73	8.90	6.30	8.6	5.33	0.7	-	4.90	0.78	93.26	17.14
Profile 8												
Ap	0.00-0.14	73.08	16.80	14.12	8.9	0.32	3.0	-	10.59	0.75	97.35	14.16
C1	0.14-0.22	80.15	10.60	9.23	8.2	0.54	1.4	-	7.50	0.81	89.33	11.20
C2	0.22-0.32	80.41	10.34	9.21	9.2	0.52	0.8	-	6.90	0.75	97.97	21.73
C3	0.32-0.55	80.40	10.40	9.20	9.4	0.38	0.7	-	5.52	0.60	97.64	25.36
C4	0.55-0.76	82.40	9.60	8.20	8.9	0.94	0.6	-	4.92	0.60	93.90	18.29
C5	0.76+	84.10	8.40	7.50	8.9	1.18	0.5	-	4.35	0.58	93.79	19.08



**Table 3.** Soil Classification

Profile No.	Order	Sub-order	Great group	Sub-group	Family
1	Inceptisol	Ustepts	Haplustepts	Vertic Haplustepts	Coarse loamy over clayey, smectitic, iso-hyperthermic, Vertic Haplustepts
2	Inceptisol	Ustepts	Haplustepts	Fluventic Haplustepts	Coarse loamy, smectitic, iso-hyperthermic, Fluventic Haplustepts
3	Entisols	Psamments	Ustipsamments	Typic Ustipsamments	Coarse loamy, smectitic, iso-hyperthermic, Typic Ustipsamments
4	Inceptisol	Ustepts	Haplustepts	Vertic Haplustepts	Fine loamy, smectitic, iso-hyperthermic, Vertic Haplustepts
5	Inceptisol	Ustepts	Haplustepts	Udifluventic Haplustepts	Clayey over loamy, smectitic, iso-hyperthermic, Udifluventic Haplustepts
6	Inceptisol	Ustepts	Haplustepts	Typic Haplustepts	Fine loamy over sandy, smectitic, iso-hyperthermic, Typic Haplustepts
7	Entisols	Psamments	Ustipsamments	Typic Ustipsamments	Coarse loamy, smectitic, iso-hyperthermic, Typic Ustipsamments
8	Entisols	Psamments	Ustipsamments	Typic Ustipsamments	Coarse loamy, smectitic, iso-hyperthermic, Typic Ustipsamments

**Classification at family level**

Profiles 1, 5 and 6 exhibited high variations in particle size distribution within control section hence were grouped under strongly contrasting particle size classes. Profiles 1, 5 and 6 had absolute difference of 25 per cent or more between clay percentages of the fine earth fraction hence were classified as coarse loamy over clayey, clayey over loamy and fine loamy over sandy respectively. Profiles 3, 7 and 8 were classified under coarse loamy as fine earth fraction contained less than 18 per cent clay. Profiles 2 and 4 have variable texture, but not sufficient to group under contrasting textural classes. Hence the weighted averages of sand, silt and clay contents were estimated and texture was derived. According to this, profile 2 was placed under coarse loamy and profile 4 under fine loamy particle size classes. The mineralogy class of all the profiles was smectitic as evident by the CEC/clay ratio of more than 0.6 (Table 2). The soils qualified for iso-hyperthermic soil temperature

regime as the difference between mean annual summer temperature (32.86) and mean annual winter temperature (28.13) was less than 6°C (Table 3).

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