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Characterization and Classification of Rice Growing Soils of Southern Telangana Region of Andhra Pradesh

M Ramprasad, V Govardhan and G Kiran Reddy
Department of Soil Science and Agricultural Chemistry, College of Agriculture, Rajendranagar,
Acharya N.G. Ranga Agricultural University, Hyderabad-30

ABSTRACT

Ten representative pedons from rice-growing soils of southern Telangana region were characterized and classified. The results showed that the soils were sandy loam to clay in texture with low permeability. The soils were neutral to slightly alkaline in reaction, low to high in organic carbon, mixed in mineralogy and moderately deep to deep. Bulk density increased with depth and values ranged from 1.26 to 1.81 Mg m^{-3}. Water retentions at 33 kPa and 1500 kPa of soils ranged from 7.9 to 38.7 % and 2.2 to 22.1 %, respectively. Cation exchange capacity and soil pH followed no definite distribution pattern with depth. The available N was low to medium and available P and K were low to high. The available N, P and K decreased with depth. Based on soil characteristics, the soils of Chevella (P1), Thandur (P4), Shadnagar (P5), Palem (P6) and Narayanpuram (P9) were classified as Alfisols, soils of Ibrahimpatnam (P3), Jadcharla (P7) and Suryapeta (P8) were grouped under Inceptisols, soils of Gollapally (P10) were classified as Entisols and soils of Rajendranagar (P2) were grayed under Vertisols.

Key words : Characterization, Classification, Rice-growing soils.

Rice crop was grown in southern Telangana region in diversified soils and resource environs predominantly with puddling and waterlogging conditions in lowland systems. Soils varied from red, lateritic, black, alluvial and colluvial soils, with heterogeneity and varied potential for nutrient supplying capacity. Nutrient supplying capacity and availability varies significantly in the waterlogged environs of low land systems due to the different farming situations adopted. The variability and heterogeneity of soil and land resource environs in the Telangana region is evidently not supplying with the requirements of rice crop.

To improve rice yields, it is important to standardize site-specific technologies on the basis of soil types which necessitates soil characterization. The present study, therefore, was planned to characterize and classify the rice growing soils of the southern Telangana region.

MATERIAL AND METHODS

The southern Telangana region is located between 16^0 11' to 17^0 31' N latitude and 77^0 33' to 80^0 52' longitude in the south India. The mean annual rainfall was 1121.6 mm, 74 per cent of which is received during monsoon (mid-June to mid-September). Ten representative pedons (P1 to P10) from Chevella, Rajendranagar, Ibrahimpatnam, Thandur, Shadnagar, Palem, Jadcharla, Suryapeta, Narayanpuram and Gollapally were exposed where all horizons were visible. All pedons were examined morphologically immediately after rice harvest. Soil samples collected from each horizon were analysed for different soil properties viz. particle-size distribution (hydrometer method), bulk density (core method), water retention characteristics (using pressure plate apparatus), saturated hydraulic conductivity (constant head method), pH (1:2.5 soil water solution), organic carbon (Walkley and Black, 1934) and cation exchange capacity (CEC) by neutral normal NH_4OAc. The soils were classified as per soil taxonomy (Soil Survey Staff, 1998 and Soil Survey Staff, 2006).

RESULTS AND DISCUSSION

Morphological characteristics

The soils had 10YR, 7.5YR and 2.5YR hue and the colour varied from very dark grayish brown to dusky red. Texture ranged from sandy loam to clay. Texture of soils was sandy clay loam (P1, P3, P4, P6, P7, P9, P10), clay (P2), sandy loam (P5) and sandy clay (P8). The paddy soils under study in general recording massive structure at the surface which broke in to subangular blocky or angular blocky structure. Structure ranged from granular to subangular blocky in pedons (Table 1).

Physical characteristics

The clay content ranged from 22.0 to 48.6 per cent and in most of the pedons clay content was increased with depth (Table 2). The increase in clay content is an indication of illuviation of clay from surface to sub-surface (Pardeep Kumar and Verma, 2005; Ratnam *et al.,* 2001). The aggregation in these soils was poor in surface and sub-surface horizons. As these soils are under rice cultivation since long, the repeated puddling during rice cultivation could be one of the reasons for poor aggregation in surface horizons. The poor aggregation in sub-surface horizons might be because of clay illuviation under continuous irrigation conditions. Rice soils have poor aggregation because of puddling or wet tillage that destroys soil structure (Dey and Sehgal, 1997).

The bulk density increased with depth in all pedons barring P7, indicating that the lower layers in soil profiles supporting rice cultivation system became compact with time. These results were in conformity with the findings of Ratnam *et al.,* (2001). The farmers plough with local (desi) plough which disturb the soil up to 20 cm only and lower layers remain undisturbed for years together which sometime result in pan formation. Because of dominance of silt and clay, the soils retained fairly good amount of water varying from 7.9 to 38.7 per cent (at field capacity). The saturated hydraulic conductivity of surface layers varied from 2.6 to 13.1 cm hr^{-1}. Similar findings were also reported by Reza *et al.,*(2010).

Chemical properties

The soils were neutral to slightly alkaline in surface (pH 6.7 to 8.1) and sub-surface horizons (pH 6.4 to 8.7) (Table 3). The organic carbon varied from 2.1 to 9.7 g kg^{-1} in surface and 0.9 to 7.6 g kg^{-1} in sub-surface horizons and decreased with depth. The temperature during rice cultivation ranged from 13.0 to 39.0^0 C. High temperature during most part of the year might be responsible for high rate of decomposition might be responsible for higher values of organic carbon in surface horizons than in sub-surface horizons. The CEC values varied from 5.9 to 45.1 cmol(p+) kg^{-1} in surface horizons and from 6.4 to 47.0 cmol(p^+) kg^{-1} in sub-surface horizons which, could be in positive correlation with clay content. Similar findings were also reported by Dhanorkar *et al.,* (2010).

The available N varied from 110.5 to 328.9 kg ha^{-1} in the surface horizons, whereas sub-surface horizons had available N in the range of 41.0 to 276.6 kg ha^{-1}. By considering ratings of Muhr *et al.* 1965, majority of the soils fell into low to medium category with respect to available nitrogen. The available P varied from 8.3 to 70.1 kg ha^{-1} in surface and 5.4 to 60.6 kg ha^{-1} in sub-surface horizons. By considering the ratings of Muhr *et al.* 1965 these values, the majority of the soils were low to high in available P. Available K ranged from 146.7 to 420.1 kg ha^{-1} in surface horizons and 88.0 to 358.6 kg ha^{-1} in sub-surface horizons. By considering the ratings of Muhr *et al.* 1965, these soils could be classified under low to high available K content. These results were similar to those of Rao *et.al.*(2008) in the soils of different land farms of Ramachandrapuram mandal of the Chitoor district in Andhra Pradesh.

Soil classification

Based on morphological, physical, physico-chemical characteristics of the soils and climate data, the soils were classified according to Keys to Soil Taxonomy (Soil Survey Staff 2006) in to the order Entisols (pedon 10) which do not have any diagnostic horizon. The presence of lithic contact that is shallower depth than 25 cm and above 1 m, having an organic corbon content decrease with increasing depth and reaches a level of 0.2 per cent at a depth of 1.25 m, not permanently saturated with water, hence placed under the Orthents at sub order level. As the moisture regime is ustic, the pedons 10 were classified as Ustorthents at great group level. This pedon 10 was classified as Udic Ustorthents at great group level because of the present land use condition, essentially good irrigation practices were followed for cultivation of crops in the last three decades. The soil and land resource environs are utilized properly, economically

Table 1. Morphological properties of the pedons.

Location	Horizon	Depth(cm)	Colour (Moist)	Mottels (Wet)	Texture	Structure C	Structure G	Structure T
	P1: Fine-loamy, mixed, iso-hyperthermic Udic Paleustalfs							
Chevella	Ap	0-16	7.5 YR 5/8	5 YR 4/5	scl	f	2	sbk
	Bt	16-45	7.5 YR 6/6	5 YR 5/6	scl	f	2	sbk
	BC	45-75	7.5 YR 5/4	7.5 YR 3/4	scl	f	2	sbk
	C	75-150+	7.5 YR 7/6	7.5 YR 4/1	scl	f	2	sbk
	Bw_1	15-36	5 YR 4/4	2.5 YR 4/4	scl	f	2	abk
	Bw_2	36-90	2.5 YR 3/4	2.5 YR 3/2	scl	f	2	sbk
	P2: Fine, smectitic, iso-hyperthermic Typic Haplusterts							
Rajendranagar	Ap	0-24	10YR 4/2	10YR 2/2	c	m	3	abk
	Bg	24-45	10YR 2/2	10YR 2/2	c	m	3	abk
	Bss_1	45-110	10YR 3/1	10YR 3/2	c	m	3	abk
	Bss_2	110+	10YR 3/1	10YR 2/2	c	m	3	abk
	P3: Fine-loamy, mixed, iso-hyperthermic Typic Haplustepts							
Ibrahimpatnam	Ap	0-15	5 YR 4/3	—	scl	f	1	sbk
	Bw_1	15-45	5 YR 4/4	—	scl	f	2	sbk
	Bw_2	45-70	5 YR 4/6	—	scl	f	3	sbk
	Bw3	70-90	5 YR 4/6	—	scl	m	2	sbk
	P4: Fine, mixed, iso-hyperthermic Typic Haplustalfs							
Thandur	Ap	0-16	7.5 YR 5/3	—	scl	f	2	sbk
	AB	16-32	7.5 YR 6/1	—	sc	f	2	abk
	Bg	32-75	7.5 YR 5/2	—	sc	f	2	abk
	Bt	75-110	7.5 YR 5/2	—	sc	f	2	abk
	C	110+	7.5 YR 5/3	—	c	f	2	abk
	P5: Fine, mixed, iso-hyperthermic Typic Paleustalfs							
Shadnagar	Ap	0-15	7.5 YR 6/4	—	sl	f	3	sbk
	Bt	15-40	7.5 YR 5/4	—	scl	f	3	sbk
	BC	40-70+	7.5 YR 5/6	—	scl	f	3	sbk
	P6: Fine, mixed, iso-hyperthermic Typic Haplustalfs							
Palem	Ap	0-18	2.5YR 4/6	2.5YR 3/4	scl	f	2	gr
	Bt_1	18-66	2.5YR 4/4	2.5YR 3/3	c	m	2	gr
	Bt_2	66-95	2.5YR 3/2	2.5YR 3/3	c	m	2	sbk
	Bt_3	95+	2.5YR 4/6	2.5YR 3/2	c	m	3	sbk
	P7: Fine-loamy, mixed, iso-hyperthermic Typic Haplustepts							
Jadcharla	Ap	0-15	5 YR 4/6	5 YR 3/2	scl	f	2	sbk
	Bw_1	15-36	5 YR 4/4	2.5 YR 4/4	scl	f	2	abk
	Bw_2	36-90	2.5 YR 3/4	2.5 YR 3/2	scl	f	2	sbk
	C	90+	2.5 YR 4/6	2.5 YR 3/3	scl	f	2	sbk
	P8: Fine, mixed, iso-hyperthermic Typic Calciustepts							
Suryapeta	Ap	0-12	10 YR 3/2	—	sc	m	2	sbk
	Bk_1	26-Dec	10 YR 3/1	—	scl	m	2	sbk
	Bk_2	26-50	10 YR 3/1	—	sc	m	3	sbk
	BC	50-100	10 YR 4/3	—	sc	m	3	sbk
	P9: Fine, mixed, iso-hyperthermic Typic Haplustalfs							
Narayanapuram	Ap	0-15	7.5 YR 3/3	—	scl	f	2	sbk
	Bt_1	15-45	7.5 YR 3/3	—	scl	f	2	sbk
	Bt_2	45-80	7.5 YR 3/4	—	c	f	3	sbk
	C	80-110+	7.5 YR 3/4	—	sc	f	2	sbk
	P10: Fine-loamy, mixed, iso-hyperthermic Udic Ustorthents							
Gollapally	A	0-14	5 YR 4/4	—	scl	f	2	gr
	AC	14-26	5 YR 4/4	—	scl	f	2	gr
	C	26-65+	5 YR 3/4	—	scl	f	2	gr

Table 2. Physical properties of the pedons.

Pedon No and Location	Horizon	Mechanical composition (%)			Bulk density Mg m^{-3}	H.C (cm/hr)	Moisture retention (%)	
		Sand	Silt	Clay			33 kPa	1500 kPa
P1:Chevella	Ap	64.0	14.0	22.0	1.39	6.6	19.7	6.5
	Bt	60.0	10.0	30.0	1.26	4.2	22.9	7.6
	BC	66.0	10.0	24.0	1.49	3.5	15.6	5.2
	C	68.0	7.0	25.0	1.51	1.2	13.2	4.5
P2:Rajendranagar	Ap	39.4	18.0	42.6	1.24	3.2	18.0	10.0
	Bg	41.4	10.0	48.6	1.32	1.5	32.8	12.6
	Bss_1	42.4	12.0	45.6	1.36	1.6	35.6	20.8
	Bss_2	43.6	14.0	42.4	1.38	0.4	42.8	22.2
P3:Ibrahimpatnam	Ap	63.1	7.1	29.8	1.39	8.4	7.9	2.2
	Bw_1	66.9	6.9	26.2	1.43	9.8	8.1	2.9
	Bw_2	67.3	6.8	25.9	1.55	7.6	9.3	3.7
	Bw3	65.2	6.9	27.9	1.61	6.4	10.1	4.1
P4:Thandur	Ap	56.0	12.0	32.0	1.27	5.8	19.4	10.9
	AB	55.0	11.0	34.0	1.29	2.6	22.9	12.6
	Bg	56.0	7.0	37.0	1.32	3.6	24.6	15.4
	Bt	49.0	6.0	45.0	1.35	2.6	26.2	19.2
	C	52.0	12.0	36.0	1.39	1.6	30.5	21.5
P5:Shadnagar	Ap	77.1	8.9	13.9	1.44	13.1	16.8	12.2
	Bt	68.1	8.3	23.6	1.55	12.6	18.8	13.6
	BC	63.0	8.6	28.3	1.56	11.8	15.2	11.1
P6:Palem	Ap	46.5	19.5	34.0	1.48	2.6	22.9	17.9
	Bt_1	21.8	30.6	48.6	1.56	1.8	30.6	17.2
	Bt_2	29.1	28.2	42.7	1.48	2.2	35.5	22.1
	Bt_3	29.3	26.4	44.3	1.51	4.8	38.7	16.9
P7:Jadcharla	Ap	66.4	7.2	26.4	1.58	8.2	14.6	8.9
	Bw_1	66.2	3.0	30.8	1.59	6.8	12.5	9.4
	Bw_2	67.4	4.0	28.6	1.52	6.1	11.9	8.4
	C	66.0	3.8	30.2	1.57	6.0	10.9	7.6
P8:Suryapeta	Ap	54.0	8.0	38.0	1.51	3.2	11.2	8.4
	Bk_1	56.0	9.0	35.0	1.56	2.9	10.7	6.2
	Bk_2	57.0	7.0	36.0	1.48	2.7	13.4	9.1
	BC	53.0	8.0	39.0	1.56	2.7	14.5	11.6
P9:Narayanapuram	Ap	65.5	12.5	22.0	1.52	8.8	12.4	6.2
	Bt_1	62.0	7.2	30.8	1.65	5.2	13.4	8.1
	Bt_2	40.3	7.0	42.7	1.81	2.1	15.2	6.6
	C	52.0	8.8	39.2	1.56	1.8	18.3	8.5
P10:Gollapally	A	63.0	10.0	27.0	1.39	3.6	10.1	6.6
	AC	68.0	7.0	25.0	1.61	2.1	14.2	8.7
	C	64.0	6.0	30.0	1.52	1.2	15.3	9.3

Table 3. Selected chemical characteristics of the pedons.

Pedon No and Location	Horizon	pH	EC ($dS\ m^{-1}$)	OC ($g\ kg^{-1}$)	CEC (c mol (p+) kg^{-1})	Available nutrients ($kg\ ha^{-1}$)		
						N	P	K
P1:Chevella	Ap	8.1	0.10	9.0	20.9	120.0	70.1	301.6
	Bt	8.3	0.21	6.0	28.6	70.0	60.6	208.1
	BC	8.4	0.16	4.0	14.9	71.0	50.4	180.6
	C	8.6	0.26	4.0	11.7	41.0	31.3	88.0
P2:Rajendranagar	Ap	8	0.80	8.0	45.1	215.4	30.6	228.1
	Bg	8.4	0.88	7.6	42.2	204.7	29.4	254.6
	Bss_1	8.7	1.20	6.1	35.2	188.4	24.7	210.0
	Bss_2	8.4	1.21	5.6	32.8	94.0	9.8	97.3
P3:Ibrahimpatnam	Ap	7.1	0.11	4.2	21.3	139.0	8.3	316.9
	Bw_1	7.6	0.11	4.6	25.2	142.0	7.2	239.6
	Bw_2	8.0	0.13	3.2	29.1	120.0	6.9	204.9
	Bw3	8.2	0.12	3.1	33.5	109.0	5.4	183.6
P4:Thandur	Ap	8.0	0.12	7.9	30.0	257.1	60.9	397.3
	AB	8.1	0.52	5.9	32.0	210.1	58.3	188.2
	Bg	8.2	0.18	4.1	35.0	163.0	43.3	181.2
	Bt	8.2	0.21	2.9	43.0	68.9	37.2	100.8
	C	8.1	0.51	2.0	47.0	43.8	20.9	92.4
P5:Shadnagar	Ap	6.7	0.28	2.4	5.9	154.2	18.1	154.6
	Bt	7.1	0.35	1.2	6.4	101.5	10.6	132.3
	BC	7.2	0.36	0.9	7.9	93.3	9.6	108.0
P6:Palem	Ap	7.0	0.60	2.1	15.2	142.6	12.8	146.7
	Bt_1	6.4	1.14	2.7	18.6	144.5	11.6	144.3
	Bt_2	7.1	0.78	2.0	19.2	94.4	9.8	131.2
	Bt_3	6.8	0.32	1.9	22.2	92.6	9.4	136.4
P7:Jadcharla	Ap	6.9	0.68	3.6	14.2	148.2	18.7	149.6
	Bw_1	6.7	0.55	5.2	26.1	150.5	16.4	132.6
	Bw_2	6.8	0.61	4.8	22.1	109.7	11.6	130.2
	C	6.9	0.58	4.1	20.8	62.7	9.4	104.6
P8:Suryapeta	Ap	8.1	0.46	6.2	26.5	110.5	12.5	214.0
	Bk_1	8.0	0.31	5.7	31.0	122.6	11.4	161.2
	Bk_2	7.8	0.26	4.2	32.5	108.2	10.2	109.5
	BC	8.1	0.41	3.0	32.5	96.2	9.2	96.2
P9:Narayanapuram	Ap	6.8	0.34	8.2	18.0	284.6	32.6	316.7
	Bt_1	6.9	0.32	4.0	20.5	181.3	10.1	309.3
	Bt_2	7.3	0.29	3.4	20.9	104.2	8.6	204.5
	C	7.3	0.30	2.1	22.1	83.3	8.4	208.6
P10:Gollapally	A	8.1	0.24	9.7	19.2	328.9	60.7	420.1
	AC	8.1	0.25	6.2	23.8	276.6	43.3	358.6
	C	8.2	0.21	4.8	28.4	158.3	21.4	202.0

providing water with various sources. Thus this influenced the moisture conditions greatly.

The pedons 1, 4, 5, 6 and 9 were classified under Alfisols because of the presence of an argillic (Bt) sub-surface diagnostic horizon and the pedons 3, 7 and 8 were classified under the order Inceptisols because of the absence of any other diagnostic horizon other than cambic (Bw) horizon. As the moisture regime is ustic, the pedons 1, 4, 5, 6 and 9 were classified as Ustalfs, whereas the pedons 3 and 7 were classified as Ustepts at sub order level and were classified as Haplustepts at great group level because the pedons did not have either duripan or calcic horizon and the base saturation is more than 60 per cent at a depth between 0.2 to 0.7 m from the soil surface. The pedons 3 and 7 were classified as Typic Haplustepts at sub group level because these pedons did not have vertic properties and lithic contact with in 50 cm from the soil surface. The pedon 8 was classified under Calciustepts at great group level because of the presence of a horizon with more than 15 per cent calcium carbonate and this pedon was classified as Typic Calciustepts at sub group level because of absence of lithic contact within 50 cm of mineral soil surface and the absence of petrocalcic, gypsic horizon within 100 cm of mineral soil surface.

The pedon 1 and 5 were classified as "Paleustalfs" at great group level because of the absence of densic, lithic or para lithic contact within 15 cm of the mineral soil surface and the lower one half of the argilic horizon, one or more sub horizons with hue of 7.5YR or redder and chroma of 5 or more in 50 per cent or more of matrix and the pedon 1 was classified as Udic Paleustalfs at sub group level because of the Present land use condition, essentially good irrigation practices were followed for cultivation of crops in the last three decades. The soil and land resource environs are utilized properly, economically providing water with various sources. Thus this influenced the moisture conditions greatly. Further the moisture was also stored in the depth profile. The pedon 5 was classified as Typic Paleustalfs at sub group level because of an argillic horizon that has hue of 2.5YR or redder and the value, moist of three or less.

The pedons 4, 6 and 9 were classified under "Haplustalfs" at great group level because, other than argillic horizon these soils not having any horizon like natric horizon, petro calcic horizon, dulipan and plinthite horizons. Further, these pedons did not have vertic properties and lithic contact with in 50 cm from the soil surface. Hence these pedons were classified under Typic Haplustalfs at subgroup level respectively.

The pedon 2 was classified under Vertisols at order level and they express their morphology very identical through out che dirth with more than 30 percent clay in fine earth fraction of all the horizons. In these pedons clay exhibited significant swell-shrink characteristics and have a layer of 25 cm (or) more thick with an upper boundary with in 100 cm of mineral soil surface, that have slickensides which exhibited shiny and smooth surfaces at interspace of peds. Due to the presence of slikensides in a soil horizon and designated as Bss. The soils were ustic in soil moisture regime, hence these pedons were classified as "Usterts" at suborder level and at great group level these pedon were calssified as Haplusterts because the soil of pedon did not have either salic, gypsic and petrocalcic horizons within 100 cm depth. This pedon had EC less than 4 dS m^{-1} and pH more than 4.5. The pedon 2 were classified as Typic Haplusterts at subgroup level because this pedon had deep cracks that remained open for more than 150 cumulative days for most years. Agarwal *et al.* (2012) classified the soils of Wardha district of Vidharbha region in to Typic Haplusterts based on above features.

The results lead to a conclusion that the rice-growing soils of southern Telangana region of Andhra Pradesh were shallow to very deep, moderately well to poorly drained, neutral to slightly alkaline, low to high in organic carbon, low to medium in CEC, moderately to high base saturated and sandy loam to clayey with variation in relation to physiography. Regarding nutrient status the soils were low to medium in available nitrogen, low to high in available phosphorous, low to high in available potassium. Different rice growing soils of Southern Telangana region of Andhra Pradesh were classified up to sub-group level.

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