An Asian Journal of Soil Science, **(June to November-2009) Vol. 4 No. 1 : 81-85**

Characterization and classification of red soils from Tamil Nadu

M. SANKAR **AND** K.S. DADHWAL

Accepted : ***April, 2009***

See end of the article for authors' affiliations

Correspondence to :

M. SANKAR
Division of Soil Science and Agronomy, Central Soil and Water Conservation Research and Training Institute, Kaulagarh Road, DEHRADUN (UTTARAKHAND) INDIA

ABSTRACT

Four typical pedons representing agriculture, forage and tree crops land uses were studied in red soil region (Kutturavupatti village of Sivagangai district) of Tamil Nadu during 2005-06. Soils were characterized for important morphological, physical and chemical characteristics to define limitations for vegetation establishment at village level. Based on soil characteristics four soil series *viz.*, Sivagangai (P_1), Melapoongudi (P_2), Tamarakki (P_3) and Keelapoongudi (P_4) were identified and named. All the soils were found deep in depth and have subangular blocky structure in surface and sub surface. The soils texture varied from loamy sand to clay. Among the pedons, more than 70% gravels were recoreded in pedon 1, whereas more than 10 % free $CaCO_3$ and high pH of 8.3 was found in pedon 3. The bulk density, available soil moisture, organic carbon and cation exchange capacity ranged from 1.11 to 1.33 Mgm^{-3}, 4.2 to 16.2%, 0.11 to 0.60% and 8.79 to 41.47 c mol (p+) kg^{-1}, respectively. The order of dominance of exchangeable bases was Ca^{2+}> Mg^{2+}>Na^{+}>K^{+}. The soils were classified into alfisol (pedon 1 and 4) and Inceptisol (pedon 2 and 3) as per USDA system of classification.

Key words : Characterization, Classification, Red soils

A proper land use is essential to realize maximum benefit out of it. As a source for production system, it serves as a store house of water and nutrients and provide environment required for plants and living organisms. For sustainable development and higher production, regional approach in agricultural development planning have not received the due attention in the past and therefore, the location specific needs of various regions remain neglected (Kadrekar,1993). In India, the availability of cultivated land is shrinking day by day, and hence, its proper management on sustainable basis has to be considered as the development strategy on priority at the smallest unit level (say village level) to meet out increasing demands. Out of 13 million ha geographical area in state of Tamil Nadu, nearly 62 % of the soils are red. To define the limitations for establishment of vegetation, characterization of the area is must. Hence, to determine the potential of soils for growing field, forage and tree crops in red soil region on sustainable basis, characterization was attempted at village level in the present study.

MATERIALS AND METHODS

The study area, lies between $78^0$25' and $78^0$30' E longitude and $9^0$55' and 10^0 00' N latitude in Kutturavupatti village of Sivaganagai district in red soil region of Tamil Nadu. The average elevation of the study area is 105 m (a msl). The area receives mean annual rainfall of 1012 mm and mean air temperature ranges from 20^0 C to 38^0 C. Soils were characterized for morphological, physical and chemical properties and individual pedons were described as per FAO, (1990). The area qualifies for ustic soil moisture regimes and isohyperthermic soil temperature regimes. The geology of the area comprises mainly gneiss in uplands, calcic gneiss and kankar nodules in the lowlands. Soils were classified upto family level as per guidelines given in USDA soil taxonomy (Soil survey staff, 1998). Soils samples were collected from each pedons horizon wise. The physical properties such as bulk density, available soil moisture, and chemical properties like pH, EC, OC, Free $CaCO_3$ and CEC were determined by adopting standard methods.

RESULTS AND DISCUSSION

Morphological characteristics:

Site and morphological characteristics of soils are given in Table 1. Pedon 1, 2 and 3 recorded solum depth of 150 cm, while it was upto 145 cm in pedon 4. The moist colour of surface soil horizons of pedons 2 was yellowish brown (7.5 YR 4/3) and pedon 3 was dark brown (10YR4/2) whereas it was dark reddish (2.5YR3/6) in profile 1 and 4. The variations are attributed due to nature and type of soil forming processes, which has also been earlier reported by Mohekar and Chella (2000). The soil texture varied from loamy sand to clay. In all the pedons soil structure was observed moderate medium sub angular in surface horizons and strong coarse subangular blocky in sub surface horizons. Moist consistency of ped was friable to firm and wet consistency was slightly sticky to moderately sticky and plastic in surface horizons whereas in sub surface horizons were mostly very firm to very friable and moderately sticky to plastic. This may be due

to higher clay content in all the subsurface horizons of pedons. Dry consistency of soil was not observed because of rainy season during the study period. Boundary of soil was clear smooth in surface and clear wavy in subsurface horizons and its thickness varied from 2.5 to 6.4cm. Pedon 3 gave mild to very strong effervescence due to presence of lime concretions (parent material plagioclase feldspars, calcium and magnesium carbonate). Similar observations have also been reported by Kaushal *et al*. (1986). The gravel content was found increasing with depth which varied from 3.5 % in pedon 3 to 70.2 % in pedon 1. Whereas, in other pedons, irregular distribution of gravel content with depth was observed. In all the pedons, iron concretions were observed in subsurface horizons at varying depths. Presence of clay film observed in pedon 1 and 2 is attributed due to the process of illuviation. Brown mottles were observed in pedon 3 with hue 10YR, chroma of 2 and value of 1 in subsurface horizons reflecting poor drainage.

Physical characteristics:

The Physical properties are presented in Table 2. The clay, silt and sand contents in soils varied from 6.50 to 46.1, 3.50 to 18.11 and 37.8 to 83.0 per cent, respectively. In pedon 1 and 3, clay content increased with depth due to illuviation of clay and its accumulation was found to be concentrated in the sub soil. Earlier Qureshi *et al*. (1996) also recorded the similar trend for illuviation of clay in Rajasthan soils. Total silt and sand distribution pattern in all the pedons was found irregular. The bulk density of the soils varied from 1.11 to 1.33 Mg m^{-3}. The progressive increase in bulk density with depth

Table 1 : Site and morphological characteristics of the soils

Horizon	Depth (cm)	Colour (Moist)	Texture	Structure	Gravel (%)	Consistency	
						moist	Wet
Pedon 1(Sivagangai) : Slope 1-3%, physiography : upland , drainage: well drained, erosion: e2							
Ap	0-15	2.5 YR3/6	Scl	c2sbk	10.2	vfr	ss&sp
Bt1	15-46	2.5 YR3/6	Sc	c2sbk	15.5	vfr	ms&p
2Bt2	46-72	2.5 YR3/4	sc (g)	c3sbk	35.4	vfr	ms&p
2Bt3	72-97	2.5 YR3/4	sc (g)	c3sbk	50.8	fr	ms&p
2Bt4	97-130	2.5 YR4/3	sc (g)	c3sbk	60.1	fr	ms&p
2Bt5	130-150	2.5 YR3/4	sc (g)	c3sbk	70.2	fr	ms&p
Pedon 2(Melapoongudi): Slope 0-1%, physiography : lowland , drainage: mod- well drained, erosion:e1							
Ap	0-20	7.5YR 4/3	Sc	c2sbk	4.2	fi	ms&p
Bw1	20-45	7.5YR 4/6	Sc	c2sbk	10.5	vfi	ms&p
Bw2	45-71	7.5YR 4/4	Sc	c2sbk	5.5	vfi	ms&p
Bw3	71-108	7.5YR 4/4	Scl	c2sbk	4.8	vfi	ms&p
Bw4	108-131	7.5YR 4/3	Ls	c3sbk	16.2	vfr	-
Bw5	131-152	7.5YR 4/4	Ls	m2sbk	15.2	fr	Ss
Pedon 3 (Tamarakki): Slope 0-1%, physiography : lowland , drainage: poorly drained, erosion: e1							
Ap	0-15	10YR4/2	Sc	m2sbk	3.5	fi	ms&p
Bw1	15-34	10YR4/2	Sc	c2sbk	5.8	vfi	ms&p
Bw2	34-62	10YR4/3	Sc	c2sbk	10.8	vfi	ms&p
Bw3	62-81	10YR4/3	Sc	c2sbk	11.2	vfi	ms&p
Bw4	81-92	10YR4/4	sc(g)	c2sbk	12.7	vfi	ms&p
Bw5	92-120	10YR4/4	sc(g)	c2sbk	22.1	vfi	ms&p
Bk	120-150	10YR4/4	C	c2sbk	25.2	vfi	vs&p
Pedon 4 (Keelapoongudi): Slope 1-3%, physiography : upland , drainage:well drained, erosion: e2							
Ap	0-22	2.5 YR3/6	Sc	c2sbk	10.4	vfr	ms&p
Bt1	22-60	2.5 YR3/6	C	c2sbk	7.2	fr	vs&p
Bt2	60-97	2.5 YR3/4	C	c2sbk	10.4	fr	vs&p
Bt3	97-133	2.5 YR3/4	sc(g)	c2sbk	14.7	vfr	ms&p
Bt4	133-145	2.5 YR4/4	sc(g)	c2sbk	18.8	vfr	ms&p

Soil texture: ls- loamy sand, sc-sandy clay, sc (g)-sandy clay gravelly, c-clay.
Soil structure: c-coarse, m-medium, 2-moderate, 3-srong, sbk- sub angular blocky.
Soil consistence: vfr –very friable, fr-friable, fi-firm, vfi-very firm.p-plastic, sp-slightly plastic, ss-slightly sticky, ms-moderate sticky, vs-very sticky.

Table 2 : Physical characterstics of the soils

Depth (cm)	VCS	Sand fractions (%)			VFS	Textural composition (%)			BD Mg m^{-3}	Available soil moist (%)
		CS	MS	FS		Sand	Silt	Clay		
Pedon 1 (Sivagangai) : Rhodic paleustalfs										
0-15	8.25	15.3	30.0	8.05.	2.20	63.9	11.0	25.05	1.25	4.6
15-46	3.28	12.13	35.1	7.47	2.28	60.2	4.61	35.02	1.25	6.5
46-72	20.49	9.55	16.5	3.75	1.67	52.0	8.04	39.50	1.17	5.9
72-97	17.96	12.80	17.5	2.95	0.52	51.7	7.30	40.50	1.25	6.7
97-130	19.40	13.80	16.6	2.54	0.40	52.8	6.01	41.08	1.14	6.6
130-150	16.71	11.72	16.9	3.73	0.59	49.7	6.02	44.04	1.33	7.3
Pedon 2 (Melapoongudi) : Typic haplustepts										
0-20	4.99	11.5	30.54	6.57	1.43	55.0	9.90	35.0	1.21	5.8
20-45	3.94	13.5	34.74	5.80	1.77	59.8	4.0	36.10	1.21	7.5
45-71	5.15	10.7	30.84	7.77	1.73	56.2	5.20	38.05	1.25	5.4
71-108	5.49	10.5	35.25	6.99	0.85	59.1	12.01	28.50	1.25	4.1
108-131	17.47	33.86	29.95	1.33	0.41	83.0	10.10	6.50	1.27	4.1
131-152	10.93	22.06	41.31	4.29	0.59	79.0	11.50	8.50	1.33	5.4
Pedon 3 (Tamarakki) : Typic haplustepts										
0-15	6.47	11.6	30.20	6.74	1.32	56.3	8.21	35.01	1.25	4.7
15-34	7.26	9.26	31.25	9.12	2.23	59.1	4.80	36.05	1.25	5.1
34-62	8.22	9.39	29.7	8.25	1.88	57.4	3.50	39.01	1.17	5.1
62-81	9.42	8.12	24.97	5.92	1.84	50.2	9.11	40.01	1.14	5.2
81-92	13.72	9.54	19.12	4.49	1.24	48.1	11.15	40.05	1.25	5.2
92-120	13.96	11.2	20.16	3.98	0.61	49.9	8.50	41.10	1.25	5.4
120-150	6.47	7.49	19.4	4.09	0.81	38.2	16.10	45.50	1.25	8.2
Pedon 4 (Keelapoongudi) : Rhodic paleustalfs										
0-22	6.22	11.9	28.49	7.09	2.22	56.0	8.41	35.10	1.25	5.2
22-60	2.72	6.97	22.8	5.35	1.76	39.6	18.11	42.05	1.14	6.5
60-97	2.50	5.77	22.9	5.05	1.54	37.8	16.01	46.10	1.17	6.9
97-133	8.68	12.1	21.2	4.57	1.69	48.3	7.05	44.50	1.11	5.7
133-145	9.87	11.8	19.7	4.37	1.60	47.4	9.02	43.14	1.25	5.9

VCS-very coarse sand, CS- coarse sand , MS –medium sand , FS-fine sand , VFS-very fine sand

was observed in pedon 2. It might be due to increase in coarse fragments of soils (Walia and Rao, 1996). Available soil moisture content was observed 4.1% in pedon 2 and 8.2% in pedon 3. It was found increasing with depth in pedon 3, whereas in case of other pedons irregular trend was observed.

Chemical characteristics:

The soil pH varied from 5.5 to 8.3. The pH of the soil was found to be increasing with depth in pedon 1, 2 and 3 which could be due to the leaching of exchangeable bases from the surface horizon. EC values ranged from 0.02 to 0.08 ds m^{-1} and thus the soils were non saline. Similar findings have also been reported by Nayak *et al.* (2000) and Vijayakumar *et al.* (1994). Organic carbon content was recorded low in pedon 2 (0.11%) and high in pedon 3 (0.60 %), which decreased with increasing depth in all the pedons. The cation exchange capacity (CEC) was low in pedon 2 (8.79 c mol (p+) kg^{-1}) to high in pedon 3 (41.5 c mol (p+) kg^{-1}). This variation is attributed due to the quality and quantity of clay and organic matter present (Mclean and Owne, 1969). CEC of pedon 1 and 3 showed increasing trend depth. Among the exchangeable cations, the order of abundance was $Ca^{2+} > Mg^{2+} > Na^{+} > K^{+}$ in all the pedons. The exchangeable Ca^{2+} and Mg^{2+} contributed for higher base saturation in these soils. Exchangeable sodium percentage (ESP) value was observed much lower than the critical level of 15% in all the pedons. The free calcium carbonate ($CaCO_3$) content was low in pedon 2 (3.09 %) to high (10.8%) in pedon 3, which may be due to Ca rich parent materials (Table 3).

Classification:

Based on soil morphological, physical and chemical characteristics studied, the soils were classified upto

Table 3 : Chemical characteristics of the soils

Depth (cm)	pH (1:2:5)	EC ds m^{-1}	OC (%)	Free $CaCO_3$ (%)	Exchangeable cations Cmol (p+) kg^{-1}			K^+	CEC Cmol (p+) kg^{-1}	BSP	ESP
					Ca^{2+}	Mg^{+2}	Na^+				
Pedon 1 (Sivagangai) : Rhodic paleustalfs											
0-15	7.7	0.07	0.59	3.57	9.5	1.00	0.17	0.21	12.9	84.6	1.32
15-46	7.8	0.03	0.25	3.77	9.00	2.5	0.29	0.07	13.9	85.2	2.08
46-72	7.8	0.04	0.19	3.72	13.0	6.0	0.42	0.10	20.7	94.2	2.02
72-97	7.8	0.05	0.19	4.01	12.5	6.0	0.46	0.06	20.9	90.8	2.19
97-130	7.9	0.05	0.16	3.86	14.5	2.5	0.40	0.05	21.0	83.2	1.90
130-150	7.9	0.06	0.14	3.96	14.0	3.5	0.41	0.07	21.0	85.5	1.95
Pedon 2 (Melapoongudi) : Typic haplustepts											
0-20	7.2	0.03	0.56	3.81	8.0	4.0	0.18	0.32	13.4	93.1	1.34
20-45	7.8	0.03	0.33	3.77	8.0	4.0	0.19	0.14	13.6	90.9	1.40
45-71	8.0	0.02	0.22	3.67	8.0	5.0	0.20	0.09	14.0	94.9	1.42
71-108	8.0	0.04	0.19	3.72	6.0	2.0	0.23	0.06	9.40	88.3	2.45
108-131	8.0	0.02	0.16	3.09	4.5	3.0	0.22	0.04	8.79	88.2	2.50
131-152	8.1	0.02	0.11	3.47	5.0	2.5	0.21	0.03	8.92	86.7	2.35
Pedon 3 (Tamarakki) : Typic haplustepts											
0-15	8.1	0.06	0.60	4.10	14.5	3.5	0.22	0.13	18.6	98.9	1.18
15-34	8.1	0.04	0.33	4.01	14.5	5.0	0.19	0.05	19.9	99.4	0.95
34-62	8.1	0.03	0.25	3.67	15.5	5.0	0.16	0.05	20.9	98.4	0.76
62-81	8.2	0.04	0.22	4.40	23.5	2.5	0.23	0.06	27.3	96.4	0.84
81-92	8.2	0.06	0.19	4.30	25.0	1.5	0.25	0.12	27.9	96.3	0.89
92-120	8.3	0.07	0.16	9.34	32.9	1.5	0.27	0.07	35.9	96.6	0.75
120-150	8.3	0.08	0.14	10.80	33.2	6.5	0.47	0.30	41.5	97.5	1.13
Pedon 4 (Keelapoongudi) : Rhodic paleustalfs											
0-22	6.9	0.04	0.33	3.43	7.5	5.0	0.16	0.50	13.8	95.5	1.16
22-60	7.3	0.03	0.22	3.09	9.0	3.0	0.16	0.14	14.9	82.6	1.07
60-97	5.7	0.05	0.16	3.72	13.0	4.0	0.31	0.08	19.8	87.7	1.56
97-133	5.5	0.07	0.16	3.28	10.5	3.0	0.59	0.13	18.1	78.5	3.2
133-145	5.5	0.03	0.14	3.33	10.9	3.5	0.48	0.11	18.0	83.3	2.6

family level (Table 4). Pedon 1 and 4 were classified as Alfisol due to presence of*argillic* horizons with the base saturation > 35 % and suborder due to the ustic soil moisture regime. These pedons were classified Rhodic Paleustalf at sub group level due to presence of argillic horizons, hue of 2.5YR and value of 3 at moist condition. Pedon 2 and 3 were classified under inceptisol due to presence of *cambic* horizon in subsurface. Suborder ustepts was coined for these two profiles based on the ustic soil moisture regime. Pedon 2 and 3 were classified under haplustepts great group due to absence of duripan, presence of free $CaCO_3$ within 200 cm of the mineral soil surface and base saturation of more than 60% in all horizons. Alfisol and Inceptisol oocupied 89 and 11% of the study area, respectively. From this study, it is inferred that characterization and classification of the soils at village

Table 4 : Classification of soils under USDA system of soil classification

Soil	Order	Sub Order	Great group	Sub group	Family
Pedon 1	Alfisol	Ustalfs	Paleustalfs	Rhodic paleustalfs	Clayey skeletal, mixed, isohyperthermic, Rhodic paleustalfs.
Pedon 2	Inceptisol	Ustepts	Haplustepts	Typic haplustepts	Fine, mixed , isohyperthermic, typic Haplustepts
Pedon 3	Inceptisol	Ustepts	Haplustepts	Typic haplustepts	Fine, mixed , isohyperthermic, typic Haplustepts
Pedon 4	Alfisol	Ustalfs	Paleustalfs	Rhodic paleustalfs	Fine, mixed , isohyperthermic, Rhodic paleustalfs

level will be very much helpful in defining limitations to grow field, forage and tree crops in red soil.

Acknowledgement:

The author M. Sankar gratefully acknowledge Dr. R. Sivasamy, Professor, Department of soil science, Tamil Nadu Agricultural University, Coimbatore for providing technical guidance during research work.

Authors' affiliations:

K.S. DADHWAL, Division of Soil Science and Agronomy, Central Soil and Water Conservation Research and Training Institute, Kaulagarh Road, DEHRADUN (UTTARAKHAND) INDIA

REFERENCES

FAO (1990). *Guidelines for soil description*. Soil resource management and conservation service. Land and water development division. Food and Agricultural Organisation, Rome, Italy.

Kadrekar, B. (1993). Nurturing finite land resource to nourish feeding millions. *J.Indian Soc.Soil Sci.,* **41**(4) : 611-622.

Kaushal, G.S., Tembhare, B.R. and Singha, S.B. (1986). Morphology and taxonomy of black soils under Bargi irrigation project in Madhya Pradesh. *J.Iindian Soc. Soil Sci.,***34** : 329-333.

Mclean, E.O. and Owen, E.J.(1969). Effects of pH on the contributing organic matter and clay to soil cation exchange. *Soil Sci.Soc.American Proce.,* **33** : 855-858

Mohekar, D.S. and Chella, O. (2000). Characterization and classification of orange growing soils in Nagpur district of Maharashtra and the effect of soil parameters on crop performance. *Agropedology*, **10** : 173-182.

Nayak, A.K., Rao, G.G., Chinchmalapture, A.R. and Singh, R. (2000). Characterization and classification of some salt affected soils of Bhal region of Gujarat. *Agropedology,* **10** (2) : 152-162.

Qureshi, E.M., Singh, S.K., Chaudhary, S.K. and Das, K. (1996). Genesis and taxonomy of some saline and sodic soils in Bharatpur (Rajasthan). *J.Indian Soc.Soil Sci.,* **44** : 130-135.

Soil Survey Staff (1998). *Key to Soil Taxonomy*, Soil Conservation Service, Eighth Edition. (USDA: Washington, D.C. USA).

Vijayakumar, T., Suryanarayana Reddy, M. and Gopalakrishna, V. (1994). Characterisation and classification of soils of Northern Telangana zone of Andhra Pradesh. *Agropedology*, **4** : 31-43.

Walia, C.S. and Rao, Y.S. (1996). Genesis, characteristics and taxonomic classification of some red soils in Bundelkhand region of Uttar Pradesh. *J. Indian Soc.Soil Sci.,* **44** (3) : 476-481.

****
******
****