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Soil Characterization of Kavalur-3 Micro-Watershed of Koppal District, North Karnataka

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ABSTRACT

A study was undertaken to characterize the soil properties of selected soil profiles of Kavalur-3 micro-watershed of Koppal District, North Karnataka and classify them taxonomically. Five representative pedons were selected for the study among five pedons, four were black and one was red soil pedon. The soils showed low bulk density (1.14 to 1.43 Mg m^{-3}) and medium water holding capacity (25.7 to 48.1%). The coefficient of linear extensibility (COLE) increased gradually from surface to subsurface horizon with COLE values ranging from 0.15 to 0.31. The soil texture varied from sandy clay to clay in case of black pedons and sandy clay loam to sandy clay in case of red pedon. The soils under the study were alkaline (8.45 to 8.81) and slightly alkaline (7.86 to 8.26) in reaction, in black pedons and red pedon, respectively and both the pedons were non-saline in nature (0.17 to 0.62 and 0.13 to 0.18 dS m^{-1} in black pedons and red pedon, respectively). The soil organic carbon content was low to medium (3.51 to 5.80 and 3.51 to 5.06 g kg^{-1} in black pedons and red pedon, respectively) and decreased with depth. The free calcium carbonates in soils ranged from 27.5 to 88.80 and 20.00 to 40.00 g kg^{-1} in black pedons and red pedon, respectively and in general, increased with depth. Cation exchange capacity, base saturation and exchangeable sodium percentage ranged from 24.0 to 45.10 cmol (p^+) kg^{-1}, 91.30 to 97.2 % and 1.32 to 8.10, respectively. The calcium and magnesium were the dominant exchangeable cations followed by sodium and potassium. Soils were classified up to Family level. Taxonomically, the soils of the study area were classified under the orders Inceptisols and alfisols.

Keywords COLE, Alkaline, Pedon, Inceptisols, Alfisols.

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INTRODUCTION

Soil characterization helps in determining soil's potential and in identifying the constraints in crop production besides giving detailed information about soil properties. The system of farming in Kavalur- 3 micro-watershed (Koppal district) is changing over years in tune with introduction of newer technologies and crops/varieties in the area as like in other parts of the State. Unfortunately, it is the soil which has to bear all these stresses and still we want it to be sustainably productive. It was felt imperative to characterize these soils for their fertility status and productivity functions so as to plan for their efficient use. Identification of soil problems helps to plan ameliorative measures and improve soil productivity. It is the need of the hour to manage our resources on a sustainable manner so that the changes proposed to meet the needs of development are brought out without diminishing their potential for future use. Systematic study of soil as natural resource provides information on nature and type of soil, their constraints, potentials, capabilities and their suitability for various uses (Sehgal 1996).

Therefore, characterization of soil resources for planning better integration of management options was considered important for enhancing and sustaining farm productivity and income in these areas of Koppal taluk.

MATERIALS AND METHODS

An investigation was carried out on soils of Kavalur-3 micro-watershed, situated at an elevation of 463.27 in nearly level to very gently sloping land of Koppal taluk, Karnataka (India) with an objective to know the physical and chemical properties of the soils. The micro-watershed lies in low rainfall zone (zone 3; northern dry zone) with an average annual rainfall of around 572 mm. Based on soil heterogeneity, five pedons belonging to different series (Figs. 1 to 5) were studied for their physico-chemical properties by using standard methods (Jackson 1973). Based on the soil morphological properties, the soils were classified up to family level by following Keys to Soil Taxonomy (Anon 2014). Details of the selected pedons were given below.

Pedon 1 (Kav-3/T_1/P_1)

Location: 15° 16′ 08.6″ N; 75° 56′ 54.6″ E
Elevation above MSL (m) : 457
Physiography: Upland
Geology : Granite gneiss

Fig. 1. Pedon 1 of Kavalur -3 micro-watershed.

Soil slope (%): 0 to 1 (nearly level)
Erosion : Moderate
Drainage: Moderately well drained

Pedon 2 (Kav-3/ T_1/P_2)

Location: 15° 16′ 12.1″ N; 75° 57′ 05.4″ E
Elevation above MSL (m) : 458
Physiography: Midland
Geology : Granite gneiss
Soil slope (%): 1 to 3 (gently sloping)

Fig. 2. Pedon 2 of Kavalur -3 micro-watershed.

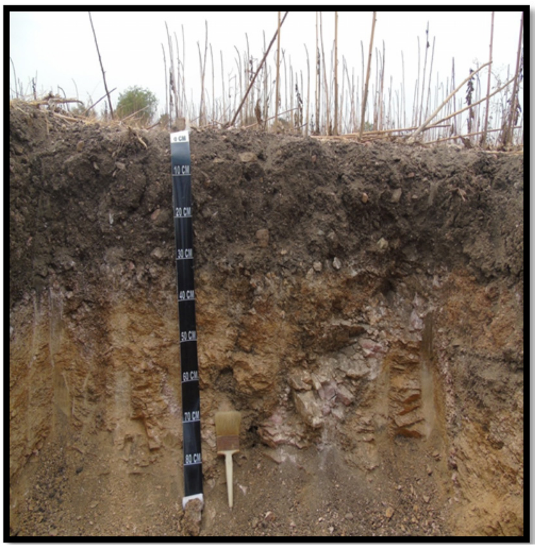

Fig. 3. Pedon 3 of Kavalur -3 micro-watershed.

Erosion : Severe
Drainage: Moderately well drained

Pedon 3 (Kav-3/T_1/P_3)

Location: 15° 16′ 16.0″ N; 75° 57′ 11.5″ E
Elevation above MSL (m) : 460
Physiography: Lowland
Geology : Granite gneiss
Soil slope (%): 1 to 3 (gently sloping)
Erosion : Severe

Fig. 4. Pedon 4 of Kavalur -3 micro-watershed.

Fig. 5. Pedon 5 of Kavalur -3 micro-watershed.

Drainage: Moderately well drained

Pedon 4 (Kav-3/ R_6)

Location: 15° 16′ 45.3″ N; 75° 56′ 40.9″ E
Elevation above MSL (m) : 458
Physiography: Midland
Geology : Granite gneiss
Soil slope (%): 0 to 1 (nearly level)
Erosion : Moderate
Drainage: Well drained

Pedon 5 (Kav-3/ R_{11})

Location: 15° 17′ 14.0″ N; 75° 55′ 47.8″ E
Elevation above MSL (m) : 472
Physiography: Midland
Geology : Granite gneiss
Soil slope (%): 1 to 3 (gently sloping)
Erosion : Very severe
Drainage: Moderately well drained

RESULTS AND DISCUSSION

Physical properties

The mean coarse sand content of black soil pedons were considerably higher (30.8 %) than that of red soil pedon (29.3%). Similarly, the mean fine sand content of red soil pedons was higher (16.4 %) compared to black soil pedons (13.3 %). The fine sand

Table 1. Physical characteristics of the red soil pedon in Kavalur-3 micro-watershed.

Horizon	Depth (cm)	Gravel (%)	Coarse sand	Fine sand	Total sand	Silt	Clay	Bulk density (Mg m^{-3})	MWHC (%)	COLE
			Particle size distribution %							
					Pedon 4					
Ap	0-12	10.8	32.9	13.6	46.5	12.6	40.9	1.14	35.1	0.15
Bt_1	12-41	11.8	29.4	16.5	45.9	11.4	42.7	1.23	37.0	0.17
Bt_2	41-67	20.4	27.2	18.2	45.4	9.2	45.4	1.28	39.0	0.17
BC	67-112	25.5	27.5	17.2	44.7	8.2	47.1	1.35	25.7	0.14
Cr	112-162+				Weathered granite gneiss					
Mean		17.1	29.3	16.4	45.6	10.4	44.0	1.25	34.2	0.2
Maximum		25.5	32.9	18.2	46.5	12.6	47.1	1.35	39.0	0.2
Minimum		10.8	27.2	13.6	44.7	8.2	40.9	1.14	25.7	0.1

content followed an irregular distribution with depth in almost all pedons .The literature suggested that the irregular distribution of sand and silt could be due to sedimentations (Bhaskar *et al*. 2004).

The total sand distribution with depth followed the same trend as that of coarse sand; was generally higher in the Ap horizon irrespective of soil type and decreased with depth except in BC horizons where usually a higher coarse sand content was observed. It indicated the variation in weathering as well as erosion of finer particles due to runoff. The total sand content was slightly higher in red soil pedon (45.6 %) compared to black soil pedons (44.0 %) (Tables 1 and 2). The observation of less sand content in black soil was corroborated by the findings Dasog and Hadimani (1980) and Asio *et al*. (2006).

There was no much difference in mean silt contents of both red (10.35 %) and black soil (9.89 %) pedons. The vertical distribution of silt in general, exhibited an irregular trend with depth, which might be due to variation in weathering of parent material or *in situ* formation (Kumar and Naidu 2012). These results were in agreement with the findings of Naidu (2002), who observed an irregular trend in silt content with depth in sugarcane growing soils of Karnataka. Similar finding was also reported by Kumar *et al.* (2002).

Higher mean clay content was observed in black soils (46.0 %) and lower in red soils (44.0 %). The clay content increased with depth in all the pedons except in BC horizons where usually lower clay content was observed. This might be due to *in situ* weathering and translocation of clays to deeper layers along with percolating water. These results are in conformity with earlier observations made by Reddy *et al*. (2005).

The mean bulk density was 1.25 Mg m^{-3} across red and black soil pedons. In general, the bulk density was less in the surface horizon and increased with depth. The bulk density of the lower solum was more than the upper solum. It could be due to the increase in clay content and decrease in organic carbon content with depth as evident from the results (Tables 1 and 2). Pulakeshi *et al*. (2014) attributed this trend to clogging of pores by dispersed clays in sub-soil layers and reduction of organic carbon with depth. This might also be due to compaction of finer particles in deeper layers caused by the over-head weight of the surface layers (Thangasamy *et al*. 2005). The lower bulk density in surface layers was attributed to cultivation, high organic matter and biotic activities (Rao *et al*. 2008).

The mean maximum water holding capacity of red soil pedons (34.20 %) was considerably lower than that of black soil pedons (43.8 %) (Tables 1 and 2). The MWHC increased downward up to certain depth and further decreased in lower horizons (BC horizon) and followed the trend of clay distribution within the profile. These differences were due to variation in soil depth, clay, silt and organic carbon content of the pedons. These results were in line with those of Thangaswamy *et al*. (2005) who observed a similar trend in soils of Sivagiri village in Chittoor District of Andhra Pradesh .

Table 2. Physical characteristics of the black soil pedons in Kavalur-3 micro-watershed.

Horizon	Depth (cm)	Gravel (%)	Particle size distribution Coarse sand	Fine sand	Total sand %	Silt	Clay	Bulk density ($Mg\ m^{-3}$)	MWHC (%)	COLE
					Pedon 1					
Ap	0-11	10.2	29.1	9.4	38.5	10.5	51.0	1.20	47.3	0.25
Bw	11-32	11.5	24.8	10.3	35.1	6.5	58.4	1.28	48.3	0.28
BC	32-68	16.9	28.4	12.1	40.5	8.6	50.9	1.32	32.1	0.24
C	68-110+				Weathered granite gneiss					
					Pedon 2					
Ap	0-9	16.2	29.8	9.6	39.6	8.6	51.8	1.14	46.2	0.27
Bw	9-30	18.7	26.6	11.1	37.7	7.9	54.4	1.29	47.4	0.31
CB	30-62	30.5	32.9	8.7	41.6	7.2	51.2	1.30	29.7	0.23
Crk	62-120+				Weathered granite gneiss					
					Pedon 3					
Ap	0-11	26.7	37.1	21.8	58.9	12.8	28.3	1.16	45.0	0.24
Bw	11-30	37.8	34.0	20.2	54.2	10.0	35.8	1.26	47.8	0.28
Cr	30-85+				Weathered granite gneiss					
					Pedon 5					
Ap	0-20	9.7	35.8	13.9	49.7	11.4	38.9	1.20	46.5	0.23
Bw_1	20-46	10.1	32.6	15.6	48.2	10.6	41.2	1.28	47.8	0.25
Bw_2	46-73	12.4	29.2	18.2	47.4	8.8	43.8	1.31	48.1	0.28
BC	3-101	13.1	32.6	15.0	47.6	9.5	42.9	1.43	29.4	0.21
Cr	101-164+				Weathered granite gneiss					
Mean		17.0	30.8	13.3	44.1	9.9	46.0	1.26	43.8	0.26
Maximum		37.8	37.1	21.8	58.9	12.8	58.4	1.43	48.8	0.31
Minimum		9.7	24.8	7.5	35.1	6.5	28.3	1.14	29.4	0.21

The coefficient of linear extensibility (COLE) is a measure of swell-shrink property of soils. The COLE increased gradually from surface to subsurface horizon. Higher COLE values were recorded in black soils (0.26) as compared to red soil (0.16). In general, the higher COLE value was accompanied by higher amount of clay (Tables 1 and 2). High clay content and abundance of smectite is known to increase COLE value (Pal *et al*. 2001 and Moustakas 2012).

Chemical properties

The soils under the study were alkaline (8.45 to 8.81) and slightly alkaline (7.86 to 8.26) in reaction, in black pedons and red pedon, respectively (Tables 3 and 4). The soil pH in the surface layer ranged from slightly alkaline to alkaline (7.86 to 8.81). The pH increased with increasing soil depth in all pedons. Red soil pedon having lower pH was compared to black soils pedons. In red soil pedon, it is likely that large amount of bases are leached out of the solum leaving behind iron and aluminium oxides and hence, lower pH in red soil pedons as compared to their black soil counterparts (Denis and Patil 2015). In all the pedons increase in pH with depth may be attributed to accumulation of exchangeable bases (Singh *et al*. 2013).

The electrical conductivity ranged from 0.13 to

Table 3. Chemical properties of red soil pedon in Kavalur-3 micro-watershed.

Horizon	Depth (cm)	$pH_{1:2.5}$	$EC_{1:2.5}$ ($dS\ m^{-1}$)	Organic carbon ($g\ kg^{-1}$)	Free $CaCO_3$ ($g\ kg^{-1}$)
		Red soil pedon Pedon 4			
Ap	0-12	7.92	0.13	5.06	20.0
Bt_1	12-41	7.86	0.14	4.29	26.3
Bt_2	41-67	8.15	0.16	4.68	32.5
BC	67-112	8.26	0.18	3.51	40.0
Cr	112-162+		Weathered granite gneiss		
Mean		8.05	0.15	4.39	29.7
Maximum		8.26	0.18	5.06	40.0
Minimum		7.86	0.13	3.51	20.0

Table 4. Chemical properties of black soil pedons in Kavalur-3 micro-watershed.

Horizon	Depth (cm)	pH $_{1:2.5}$	$EC_{1:2.5}$ (dS m^{-1})	Organic carbon (g kg^{-1})	Free $CaCO_3$ (g kg^{-1})
			Black soil pedon		
			Pedon 1		
Ap	0-11	8.56	0.17	5.06	55.0
Bw	11-32	8.70	0.19	4.68	67.5
BC	32-68	8.82	0.23	3.90	88.8
C	68-110+		Weathered granite gneiss		
			Pedon 2		
Ap	0-9	8.60	0.27	4.68	68.8
Bw	9-30	8.45	0.29	3.90	75.0
CB	30-62	8.80	0.33	3.51	80.0
Crk	62-120+		Weathered granite gneiss		
			Pedon 3		
Ap	0-11	8.57	0.45	4.68	70.0
Bw	11-30	8.75	0.62	3.51	78.8
Cr	30-85+		Weathered granite gneiss		
			Pedon 5		
Ap	0-20	8.45	0.26	5.80	27.5
Bw_1	20-46	8.61	0.28	4.71	36.3
Bw_2	46-73	8.76	0.31	4.32	41.3
BC	73-101	8.81	0.33	3.51	45.0
Cr	101-164+		Weathered granite gneiss		
Mean		8.65	0.30	4.26	67.6
Maximum		8.82	0.62	5.80	116.3
Minimum		8.45	0.17	3.51	27.5

0.18 dS m^{-1} in red soil pedon and from 0.17 to 0.62 dS m^{-1} in case of black soil pedons (Tables 3 and 4). The black soil pedons had more EC than red soil pedon indicating that the black soil pedons were less leached compared to associated red soil pedons. The soluble salt distribution showed increased with increasing soil depth in almost all pedons.These results are in conformity with the findings of Sivasankaran *et al.* (1993) and Dabi (2011).

The soil organic carbon content ranged from 3.51 to 5.06 g kg^{-1} in red soil pedon while from 3.51 to 5.80 g kg^{-1} in black soil pedons (Tables 3 and 4). Generally, black soil pedons contained more organic carbon than red soil pedon. The higher organic carbon content might be due to the presence of clay- humus complexes (Harshitha 2012). In all the pedons, the organic carbon content was higher in the surface and decreased with depth. It is naturally expected as plant residues and farm yard manure were applied to surface horizons (Kumar and Prasad 2010).

The free $CaCO^3$ is the dispersed precipitate of calcium carbonate in the solum. The free calcium carbonate in soil ranged from 20.00 to 40.0 g kg^{-1} in red soil pedons and it varied from 27.5 to 116.30 g kg^{-1} in case of black pedons (Tables 3 and 4). Generally, black soil pedons contained more free $CaCO_3$ than red soil pedon. The higher accumulation of free lime in black soil pedons compared to red soil pedon was due to their base rich parent materials. This fact was in concordance with the observations made by Ravikumar *et al*. (2009) and Pulakeshi *et al*. (2014). In all the pedons increase in free $CaCO_3$ with depth-which was attributed to variable nature of geological material that contributed to these soils or extent of leaching of carbonates facilitated by variable texture of soils (Singh and Agrawal 2005).

Exchangeable bases, across pedons were in the order of $Ca^{2+} > Mg^{2+} > Na^+ > K^+$ on the exchange complex (Tables 5 and 6). The exchangeable calcium content ranged from 16.4 to 19.2 cmol (p^+) kg^{-1} in case of red soil pedon and it ranged from 17.1 to 29.1 cmol (p^+) kg^{-1} in case of black soil pedons. The exchangeable magnesium content ranged from 3.4 to 5.7 cmol (p^+) kg^{-1} in red soil pedon and in case of black soil pedons, it ranged from 4.9 to 10.7 cmol (p^+) kg^{-1}. Comparatively, black soil pedon had more exchangeable calcium and magnesium than of red soil pedon. In most of the pedons, exchangeable calcium and magnesium content showed irregular trend with depth. Similar reports were made by Deshmukh *et al.* (2012) and Pulakeshi *et al*. (2014).

Among the exchangeable bases, calcium dominated over magnesium followed by sodium and potassium (Tables 5 and 6). Similar cationic predominance was reported by Khan and Kamalakar (2012) and Balpande *et al*. (2007). The low Mg^{2+}content than Ca^{2+} in all soil pedons is attributed to higher mobility of Mg^{2+} over Ca^{2+} in soils. The low value of exchangeable monovalents compared to divalents was attributed to preferential leaching of monovalents than divalents. These findings of dominance of divalent cations than the monovalent cations are in accordance with the findings of Thangaswamy *et al*. (2005).

Table 5. Exchangeable cations in red soil pedon of Kavalur-3 micro-watershed.

Hori-zon	Depth (cm)	Ca^{2+}	Mg^{2+}	K^+	Na^+	CEC	BS (%)	ESP
			[cmol (p^+) kg^{-1}]					
				Red soil pedon				
				Pedon 4				
Ap	0-12	17.5	3.4	0.48	0.45	24.0	91.3	1.88
Bt_1	12-41	16.4	5.7	0.41	0.38	24.7	92.6	1.53
Bt_2	41-67	18.2	5.3	0.39	0.42	26.1	93.0	1.62
BC	67-112	19.2	4.9	0.32	0.36	27.0	91.6	1.32
Cr	112-162+				Weathered granite gneiss			
Mean		17.83	4.83	0.40	0.40	25.45	92.13	1.59
Maximum		19.20	5.70	0.48	0.45	27.00	93.00	1.88
Minimum		16.40	3.40	0.32	0.36	24.00	91.30	1.32

The exchangeable potassium ranged from 0.32 to 0.48 cmol (p^+) kg^{-1} in case of red soil pedon and in black soil pedons, it ranged from 0.21 to 0.73 cmol (p^+) kg^{-1} and the exchangeable sodium content ranged from 0.36 to 0.45 cmol (p^+) kg^{-1} in the case of red soil pedon and in case of black soil pedons, it ranged from 1.17 to 3.08 cmol (p^+) kg^{-1}. Comparatively, black soil pedon had higher exchangeable potassium and sodium than red soil pedons (Tables 5 and 6). In most of the pedons, the vertical distribution of exchangeable potassium and sodium showed irregular trend with depth. This fact was in concordance with the observations made by Pulakeshi *et al*. (2014).

Table 6. Exchangeable cations in black soil pedons of Kavalur-3 micro-watershed.

Hori-zon	Depth (cm)	Ca^{2+}	Mg^{2+}	K^+	Na^+	CEC	BS (%)	ESP
			[cmol (p^+) kg^{-1}]					
				Black soil pedons				
				Pedon 1				
Ap	0-11	24.4	9.0	0.68	2.38	38.2	95.2	6.23
Bw	11-32	24.9	9.4	0.71	2.93	45.1	84.1	6.49
BC	32-68	23.6	8.9	0.73	3.08	38.0	95.4	8.10
C	68-110+				Weathered granite gneiss			
				Pedon 2				
Ap	0-9	26.0	9.4	0.27	2.39	40.3	94.2	5.92
Bw	9-30	27.2	10.2	0.23	2.27	41.2	96.8	5.50
CB	30-62	29.1	10.7	0.21	2.64	43.9	97.2	6.03
Crk	62-120+				Weathered granite gneiss			
				Pedon 3				
Ap	0-11	17.1	5.3	0.29	1.19	26.8	88.8	4.45
Bw	11-30	20.2	4.9	0.32	1.73	28.4	95.5	6.11
Cr	30-85+				Weathered granite gneiss			
				Pedon 5				
Ap	0-20	21.4	5.3	0.72	1.17	32.6	87.6	3.60
Bw_1	20-46	21.1	7.7	0.65	2.57	35.2	90.9	7.30
Bw_2	46-73	22.3	7.0	0.59	2.56	34.3	94.6	7.46
BC	73-101	24.2	8.6	0.60	2.72	38.9	92.8	7.00
Cr	101-164+				Weathered granite gneiss			
Mean		23.8	8.0	0.49	2.21	37.0	93.0	5.93
Maximum		29.1	10.7	0.73	3.08	45.1	97.2	8.10
minimum		17.1	4.9	0.21	1.17	26.8	84.1	3.49

The cation exchange capacity ranged from 24.0 to 27.0 cmol (p^+) kg^{-1} in case of red soil pedon and in black soil pedons, it ranged from 26.8 to 45.1 cmol (p^+) kg^{-1} (Tables 5 and 6). In most of the soil pedons, CEC increased with depth (except in BC horizons) which could be attributed to increase in clay content at lower depths. The results are endorsed by the findings of Kumar *et al*. (2005), Rao *et al*. (2008) and Leelavathi *et al*. (2009). The magnitudes of CEC were indicative of presence of mixed type of clay minerals in the pedons. Variation in clay type and content, organic matter and presence of free iron oxides were responsible for variation in CEC in different pedons at varying physiographic positions.

The base saturation and ESP ranged from 84.1 to 97.2 % and 1.32 to 8.10 %, respectively (Tables 5 and 6). The higher base saturation in black soils was due to the prevailing semi-arid climate facilitating less leaching and more accumulation of bases. Sekhar *et al*. (2014) and Das and Shinde (2014) also observed direct relation between base saturation and accumulation of bases due to less leaching.

Soils of Kavalur-3 micro-watershed varied with respect to morphological properties and were classified based on these at the order level as Inceptisol and Alfisol.

The soil classification (up to family level) was done as per revisions of US Soil Taxonomy (Anon.2014) (Table 7). Soil pedons 1, 2, 3 and 5 were grouped under the order- Inceptisol, suborder-ustepts, great group- Haplustepts, subgroup- Vertic Haplustepts and family- clayey mixed superactive isohyperthermic.

The pedons 1, 2, 3 and 5 were grouped under

Table 7. Classification of soil pedons.

Pedon	Soil classification	Order
4	Fine, mixed, active, isohyperthermic, Typic Rhodustalfs	Alfisol
1, 2, 3 and 5	Clayey, smectite, superactive, isohyperthermic, Vertic Haplustepts	Inceptisol

order Inceptisol owing to the presence of cambic horizon. Because of the prevailing ustic moisture regime, they were identified as Ustepts under suborder. At the great group level, were classified as Vertic Haplustepts as they possessed cracks within 125 cm of the mineral soil surface.

Soil pedon 4 was grouped under the order-Alfisol, suborder-ustalfs, great group Rhodustalfs, subgroup-Typic Rhodustalfs and family- fine mixed active isohyperthermic.Pedons 4 belonging to red soil showed mixed mineralogy.

The pedon 4 was classified under order Alfisol as they possessed argillic horizon and base saturation was more than 35 %. Since moisture regime was ustic, it was classified under suborder Ustalfs. The pedon 4 was classified as Rhodustalfs due to occurrence of sub-horizons within upper 100 cm of the argillic horizon or throughout the entire argillic horizon if < 100 cm thick, with > 50 % colors that have hue of 2.5YR, value (moist) of 3 or less, dry value no more than one unit higher than the moist value and do not have a natric or kandic horizon. At the sub-group level, because of absence of inter-gradation with other taxa or an extra-gradation from the central concept, the pedons were keyed out as Typic Rhodustalfs.

CONCLUSION

The soils of Kavalur-3 micro-watershed were sandy clay loam to clay in texture with noticeably low bulk density and high water holding capacity. The coefficient of linear extensibility (COLE) values indicated swell-shrink properties of soils and gradually increased from surface to subsurface horizon owing to clay intensification. The soils were slightly alkaline to alkaline in reaction and were non-saline. The organic carbon content was low to medium. The soils had considerably higher amounts of free calcium carbonate and cation exchange capacity, both increased with depth. The base saturation and exchangeable sodium percentage showed irregular trend with depth. The calcium and magnesium were the dominant exchangeable cations followed by sodium and potassium. The soil classification (up to family level) as per revisions of US Soil Taxonomy revealed that pedons under study belonged to Inceptisol and Alfisol.

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