International Journal of Plant & Soil Science

Volume 36, Issue 2, Page 258-274, 2024; Article no.IJPSS.112585
ISSN: 2320-7035

Taxonomical Approach on Different Soil Types of Kalyana Karnataka, India

Kiranakumara [a++*], Rudramurthy H. V. [b#], Basavaraj K. [c†], Rajesh N. L. [d‡], Channabsavanna A. S. [e^], Sathishkumar U. [f##] and Vijaya Wali [g#^]

[a] Department of Soil Science and Agricultural Chemistry, UAS, Raichur, India.
[b] Department of Soil Science and Agricultural Chemistry, College of Agriculture, Bheemarayanagudi, UAS, Raichur, India.
[c] Department of Soil Science Zonal Agricultural Research Station, Kalaburgi, UAS, Raichur, India.
[d] Department of Soil Science and Agricultural Chemistry, College of Agriculture, Raichur, UAS, Raichur, India.
[e] Department of Agronomy, UAS, Raichur, India.
[f] Department of Soil and Water Engineering, College of Agricultural Engineering, Raichur, UAS, Raichur UAS, Raichur, India.
[g] Department of Agricultural Economics, UAS, Raichur, India.

Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

Article Information

DOI: 10.9734/IJPSS/2024/v36i24388

Open Peer Review History:
This journal follows the Advanced Open Peer Review policy. Identity of the Reviewers, Editor(s) and additional Reviewers, peer review comments, different versions of the manuscript, comments of the editors, etc are available here: https://www.sdiarticle5.com/review-history/112585

Original Research Article

Received: 26/11/2023
Accepted: 30/01/2024
Published: 02/02/2024

[++] PhD Scholor;
[#] Associate Professor and Head;
[†] Senior Scientist;
[‡] Assistant Professor;
[^] Retired Professor;
[##] Professor and Head;
[#^] Assistant Professor of Statistics;
**Corresponding author: E-mail: kiransoilp@gmail.com;*

ABSTRACT

The three types of soils namely red, lateritic and black soils from Kalyana Karnataka, India, belonged to selected soil series derived from diversified geology, topography, climate and vegetation were characterized and classified based on geomorphological, morphological, physical and chemical soil properties. Red and lateritic soils series other than Badrapur, Kodambal, Rummanagunda and Kallarahatti series were classified as Typic Haplustepts while Badrapur, Kodambal, Rummanagunda and Kallarahatti series as Lithic Haplustepts at sub group level. All the black soils series other than Margutti series were keyed out as Typic Haplusterts while Margutti series as Lithic Haplusterts at subgroup level.

Keywords: Inceptisol; vertisol; taxonomy.

1. INTRODUCTION

Mother nature is highly diversified and soil being a part of it is also not exceptional and thus the earth planet is bestowed with different types of soils and characterization of these soil types for geomorphological, morphological, physical and chemical properties is very much essential for soil classification.

Taxonomical approach on soils is essential to better understand the soils for their proper usage as well as management in addition to transfer of technology and thus taxonomical studies on soils is helpful in identifying potentials, constraints and management units of soils and thereby intervention of specific management practices for specific soils and crops for long last sustainable soil productivity [1] to feed the burgeoning world population and is need of the hour. Thus taxonomical approach on red, lateritic and black soils belonged to selected soil series of Kalyana Karnataka was taken up.

2. MATERIALS AND METHODS

The study area (Fig. 1) is comprised of four districts namely Bidar, Kalaburgi, Yadgir and Raichur of Kalyana Karnataka region falls under Agro climatic zones I, II & III of Karnataka. In these districts established eighteen soil series, six from each soil type namely red, lateritic each and black soils series were selected to classify the soils at sub group level as per USDA. The extent of geographical area of these soil series selected for study was delineated using Cartosat-1 merged with LISS- IV satellite imagery and SOI toposheet [2]. Out of six lateritic soil series four were from Bidar and two were from Kalaburgi districts. Among red soil series, four were from Raichur and two were from Kalaburgi districts. Out of six black soil series, two were from Kalburgi , three were from Raichur and one was from Yadgir districts (Fig. 1).

Study area was traversed with cadastral map and geology map. The cadastral map was overlaid on LISS-IV merged Cartosat-I imagery. The coordinates of representative pedons excavating spots of selected soil series were collected using Juno SD (Trimble Make) handheld GPS locations were imported to ArcGIS and overlaid on the soil series boundary and the spatial variation in soil series of selected area was delineated. The geographical area under each soil series from the selected part of Kalyana Karnataka is presented in Table 1.

Study area in Bidar is characterized by the Deccan trap whereas in Kalburgi it is dominated by Deccan trap with intertrapppean with flows. Study area in Raichur is characterized by Granite, Gneiss and Schist geology where as in Yadgir study area comprised of Granite and Gneiss geology (Fig. 2). Geographical locations of the sampling spots and elevations above MSL were recorded using GPS. At these profile sampling spots, pits of one square meter size were excavated up to the depth of parent material.

One representative pedon from each soil series was excavated and profile site of each soil series was studied for the geomorphological features (Table 1) such as surface stoniness, slope, drainage, erosion and soil depth classes as per USDA [3]. Based on visual observations such as colour, coarse fragments, nodules, slickensides, root distribution, clay movement, compactness etc. soil horizons were demarcated in these pedons and horizon wise these pedons were examined for morphological features such as colour, texture, structure, consistency and other pedalogical features, such as lime nodules, clay skins, pressure faces, slickensides *etc*., The terminologies used to describe the pedons were as per Anonymous [3].

Table1. Geomorphological features of lateritic, red and black soils series

Series	Longitude	Latitude	Area (ha)	Solum depth class	Slope class	Erosion class	Drainage class	Surface gravels/stones	Physio graphy
Lateritic soil									
BDP(Badrapur)	77°16'591"	17°16'576"	8916	Very Shallow	A	e1	d5	Nongravelly	Upland
KDM (Kodambal)	77°27'111"	17°86'321"	12951	Very Shallow	A	e1	d5	Stony	Upland
MST (Mustari)	77°28'1411"	17°64'122"	3341	Shallow	B	e2	d5	Gravelly	Midland
MTN (Muttanga)	77°15'91"587	17°83'18"049	2706	Deep	B	e2	d5	Gravelly	Midland
BHN (Bachanal)	77'01'21"512	17°38'091"	222	Moderately shallow	D	e3	d5	Gravelly	Upland
KKT (Kurkota)	77°01'361"	17^0 38'064"	216	Deep	D	e3	d5	Stony	Upland
Red soil									
RMG(Rummanagunda)	$76^0$52'25"721	17°36'01"421	1073	Very Shallow	C	e3	d5	35-60	Upland
KGI (Kalamandargi)	77°01'01"536	17°38'26"433	1088	Shallow	C	e3	d5	15-35	Midland
CHR (Chatra)	77°33'554"	16°00'39"318	11028	Shallow	C	e2	d5	-	Midland
THD (Thodki)	77°33'996"	15°99'441"	5549	Moderately Shallow	C	e2	d4	15-35	Midland
KAL (Kallarahatti)	76°82'650"	15°12'47"803	10866	Very Shallow	C	e2	d5	-	Upland
PKM (Palkanamardi)	76°82'266"277	16°12'266"	2697	Moderately Shallow	C	e2	d4	15-35	Midland
Black soil									
RNL (Rajnal)	76°48'28"284	17°37'02"167	5052	Very deep	C	e3	d3	15-35	Low land
MGT (Margutti)	76°43'25"512	17°37'28"406	19371	Very Shallow	C	e3	d3	35-60	Midland
KLU (Kolur)	77°23'15"84	16°46'52"350	5267	Deep	B	e2	d3	-	Low land
HEG (Heggapur)	77°33'123"	16°19'952"	6533	Moderately Shallow	B	e2	d3	-	Low land
KML (Kalmala)	77°10'55"191	16°08'389"87	13039	Deep	B	e2	d3	-	Low land
NAG (Naglapura)	77°20'38"397	16°49'562"	9669	Deep	C	e2	d3	-	Midland

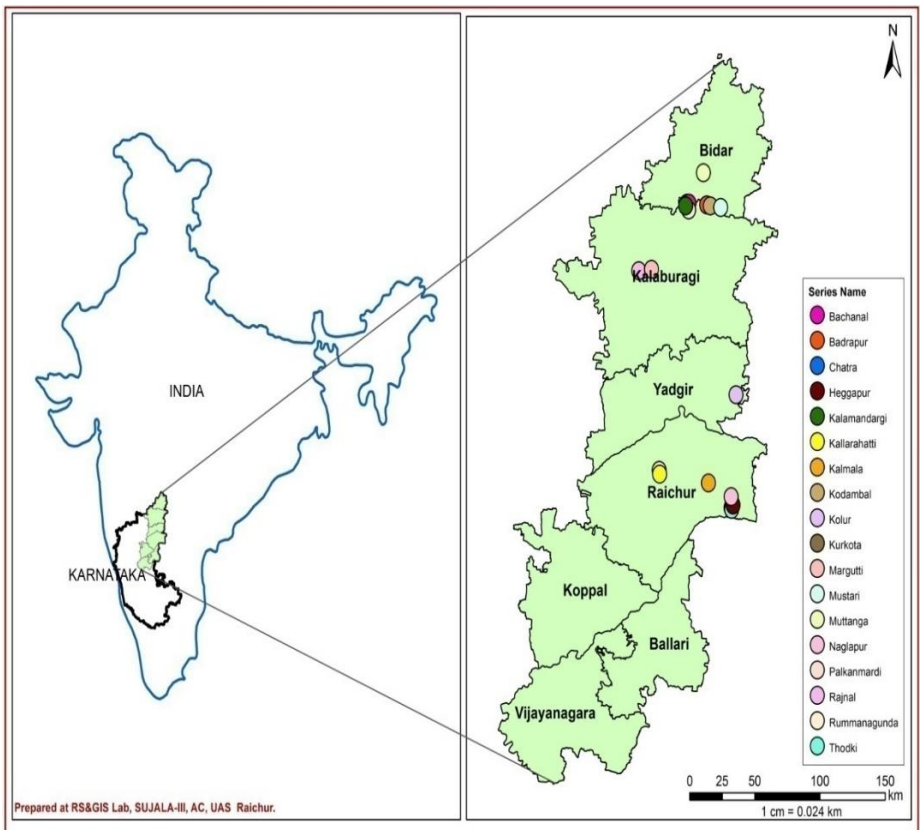

Fig. 1. Location map of soil profile sampling sites of the soils series

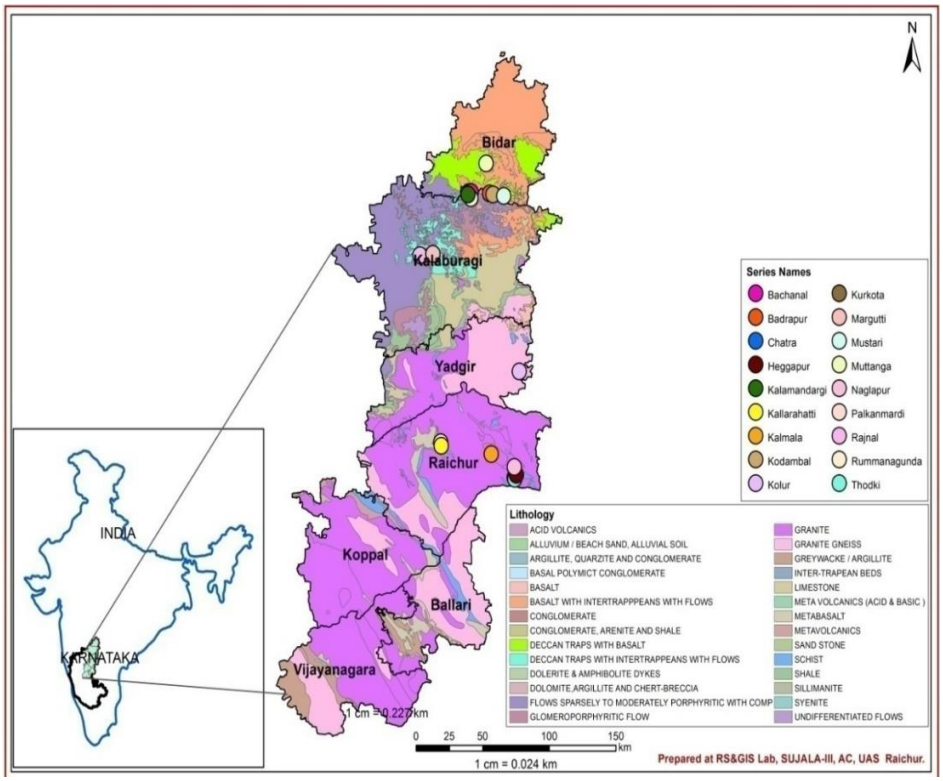

Fig. 2. Geology map of soil profile sampling sites of the soils series

Study area enjoys semi-arid climate. The mean monthly maximum temperature ranged from 28.23, 29.95, 30.75 and 30.08 ^{o}C (December) to 38.66, 39.21, 40.95 and 39.75 ^{o}C (May) with mean annual maximum temperature of 31.89, 32.98, 34.28 and 33.76^{o}C and mean monthly minimum temperature (Table 2) ranged from 13.76, 16.73, 16.00, and 16.44 (January) to 24.39, 26.37, 27.00 and 26.35 ^{o}C (May) with mean annual minimum temperature of 18.96, 21.88, 21.77 and 21.66 ^{o}C in the Bidar, Kalaburgi, Yadgir and Raichur district respectively. The mean annual rainfall is 905.70, 908.67, 630.92 and 726.63 mm in the Bidar, Kalaburgi, Yadgir and Raichur district respectively.

3. RESULTS AND DISCUSSION

The results pertaining to geomorphological and morphological features (Table 2) as well as CEC and Clay of lateritic, red and black soils series are presented and discussed under following headings.

3.1 Solum Depth

Among lateritic soils series, both Muttanga and Kurkota soils series belonged to the soil depth class deep while that of Bachanal soil series belonged to soil depth class moderately shallow.Soil depth class of Mustari soil series was shallow while that of both Kodambal and Badrapur were very shallow (<25cm). Among red soils series, Thodki and Palkamaradi soil series belonged to soil depth class moderately shallow and both Chatra and Kalamandargi soil series belonged to shallow depth class while that of both Kallarahatti and Rummanagunda were very shallow respectively. As both red and lateritic red soils are situated at elevated position of the topography were subjected to varied rate of removal of weathering products from the site of formation and thus soil depth class of these soils ranged from very shallow to deep and these results are in line with Bhaskar and Subbaiah [4].

Among black soils series, Rajhanal soil series was very deep while Kolur and Kalmalli soil series were deep. Soil depth classes of Nagalapur and Heggapur soil series were moderately deep and moderately shallow, respectively while that of Maragutti was very shallow in nature.Very deep to deep and moderate depth classes of black soils series could be attributed to the topographic position depressions where eroded materials are accumulated while very shallow depth class of black soil could be attributed to more rate of soil erosion than the rate of soil formation and similar kind of observations were reported by Singh and Rathore [5].

3.2 Soil Colour

All lateritic and red soils series registered soil colour hue 5YR with exception to Badrapur series where it was 2.5 YR and this could be attributed to higher amount of iron oxides in Badrapur series while all black soils witnessed soil colour hue 10 YR with exception to Margutti series where it was 7.5 YR. Variation in soil colour hue of all the soils series from 2.5 YR to 10 YR via 5 YR and 7.5 YR could be attributed to redox conditions of the soils.More of yellower hue in black soils and more of redder hue in both lateritic and red soils could be attributed to impeded drainage in the former soils unlike that of latter soils and this could also be attributed to the more of chemical than physical weathering in addition to presence of appreciable amount of free $CaCO_3$, clay humus complex with lime in black soils than in red and lateritic soils and these finding are in agreement with Singh [6] and Rudramurthy and Dasog (2001).The moist value and chroma of lateritic, red and black soils ranged from 3-5 and 4-6, 3-7 and 3-5 and 3-4 and 1-2.5 respectively. Comparatively lesser soil moist chroma (1-3) in black soils than in both red (2-5) and lateritic(4-6) soils could be attributed to the differences in drainage. Among black soils series, both Rajnal and Margutti recorded the lowest (1-2) moist soil chroma while the remaining black soil series registered the highest(1.5-3) moist soil chroma and this could be attributed to the differences in the parent material of the soils series as the former soils series are derived from clay forming low silicious basalt while the rest of the soils series derived from highly silicious granite and granite-gneiss and similar kind of observations were reported by Basavaraju et al. [7]; Nagraj et al. [8] and Praveen [9].

Table 2. Soil Morphological features and CEC/Clay ratio of lateritic, red and black soils series

Depth(cm)	Horizon	Color		Structure	Consistency			Specialfeatures	Effervescence
		Dry	Moist		Dry	Moist	Wet		
Lateritic soils									
Kurkota series (Basalt)									
0-12	Ap	5YR5/5	5YR 5/4	1mgr	sh	L	ss,sp	-	No
12-32	Bw1	5YR5/6	5YR5/5	2msbk	sh	fr	ss,sp	-	No
32-61	Bw2	5YR5/6	5YR5/5.5	2msbk	h	fr	ss,sp	-	No
61-97	Bw3	5 YR 4/6	5YR4/5	2msbk	h	fr	ss,sp	-	No
97-110	BC	5 YR 5/8	5YR5/6	2msbk	h	fr	ss,sp	-	No
0-10	Ap	5YR5/5.5	5YR5/5	1msbk	sh	fr	ss,sp	-	No
10-28	Bw1	5YR5/6	5YR5/5.5	2msbk	sh	fr	ss,sp	-	No
28-50	Bw2	5 YR 4/6	5YR4/5	2msbk	h	fr	ss,sp	-	No
50-60	BC	5 YR 5/8	5YR5/6	2msbk	h	fr	ss,sp	-	No
Muttanga series (Basalt)									
0-15	Ap	5YR 5/4	5YR 4/4	2fsbk	sh	fr	ss,sp	-	No
15-38	Bw1	5YR4/6	5YR4/4.5	2fsbk	sh	fr	ss,sp	-	No
38-85	Bw2	5YR4/5.5	5YR4/5	2fsbk	h	fr	ss,sp	-	No
85-118	Bw3	5YR4/6	5YR4/5	2msbk	h	fr	ss,sp	-	No
118-150	BC	5YR4/6	5YR4/5.5	2msbk	vh	fr	ms,mp	-	No

Table 2. Continued

Depth(cm)	Horizon	Color		Structure	Consistency			Specialfeatures	Effervescence
		Dry	Moist		Dry	Moist	Wet		
Badrapur series (Basalt)									
0-9	Ap	2.5 YR4/6	2.5 YR4/5	1fgr	sh	fr	ss,sp	-	No
9-17	BC	2.5YR3.5/6	2.5YR3.5/5	2msbk	sh	fr	ss,sp	-	No
Kodambal series(Basalt)									
0-7	Ap	5 YR 4/6	5 YR 4/5	1msbk	sh	fr	ss,sp	-	No
7-10	Bw1	5 YR 4/5	5 YR 4/4	2msbk	sh	fr	ss,sp	-	No
10-15	BC	5 YR 4/6	5 YR 4/5	2msbk	sh	fr	ss,sp	-	No
Mustari Series (Basalt)									
0-12	Ap	5YR5/5	5YR5/4	1fgr	sh	fr	ss,sp	-	No
12-32	Bw1	5YR4/6	5YR4/5	2fsbk	sh	fr	ss,sp	-	No
32-48	BC	5YR4/5.5	5YR5/4	2msbk	h	fr	ms,mp	-	No
Red soils									
Rummanagunda series (Basalt)									
0-15	Ap	5YR4/3	5YR3/4	2msbk	sh	fr	ss,sp	-	No
15-24	BC	5YR4/4	5YR4/4	2msbk	h	fr	ss,sp	-	No
Kalamandargi series (Basalt)									
0-12	Ap	5YR4/4	5YR4/3	1msbk	sh	fr	ss,sp	-	No
12-25	Bw1	5YR4/4	5YR4/3.5	2msbk	sh	fr	ss,sp	-	No
25-43	Bw2	5YR4/5	5YR4/4	2msbk	h	fr	ss,sp	-	No
43-50	BC	5YR4/4	5YR4/3.5	2msbk	h	fr	ss,sp	-	No

Table 2. Continued

Depth(cm)	Horizon	Color		Structure	Consistency			Specialfeatures	Effervesence
		Dry	Moist		Dry	Moist	Wet		
Chatra series (Granite)									
0-15	Ap	5YR4/6	5YR4/5	1fgr	sh	fr	ss,sp	-	No
15-37	BC	5YR4/5	5YR4/4	2msbk	h	fr	ss,sp	-	No
Thodki series (Granite)									
0-15	Ap	5YR4/5	5YR4/4	1fsbk	sh	fr	ss,sp	-	No
15-35	Bw1	5YR4/4	5YR4/3.5	2msbk	h	fr	ss,sp	-	No
35-68	BC	5YR4/4.5	5YR4/4	2msbk	h	fr	ms,mp	-	
Kallarahatti series (Granite)									
0-8	Ap	5YR4/4	5YR4/3.5	2msbk	sh	fr	ss,sp	-	No
8-15	Bw1	5YR4/4.5	5YR4/4	2msbk	sh	fr	ss,sp	-	No
15-20	Bw2	5YR4/5	5YR4/4.5	2msbk	h	fr	ss,sp	-	No
20-25	BC	5YR6/6	5YR6/4	2msbk	h	fr	ss,sp	-	No
Palkamaradi series (Schiest)									
0-12	Ap	5YR3/4	5YR3/3.5	1msbk	sh	fr	ss,sp	-	No
12-23	Bw1	5YR3/4	5YR3/3	2msbk	sh	fr	ss,sp	-	No
23-35	Bw2	5YR3/3	5YR3/2	2msbk	sh	fr	ss,sp	-	No
35-48	Bw3	5YR4/4	5YR4/3	2msbk	sh	fr	ss,sp	-	No
48-58	Bw4	5YR4/4	5YR4/3.5	2msbk	h	fr	sssp	-	No
58-64	Bw5	5YR4/4	5YR4/3	2msbk	h	fr	ss,sp	-	No
64-75	BC	5YR5/3	5YR5/3	2msbk	h	fr	ss,sp	-	

Table 2. Continued

Depth(cm)	Horizon	Color		Structure	Consistency			Specialfeatures	Effervesence
		Dry	Moist		Dry	Moist	Wet		
Rajnal series (Basalt)									
0.-20	Ap	10YR3/2	10YR3/1.5	2msbk	h	fi	s,p	-	Strong
20-48	Bw	10YR3/2	10YR3/1.5	2msbk	h	fi	s,p	-	Strong
48-78	Bss1	10YR3/2	10YR3/1	2mabk	h	vfi	vs,vp	Slickenslides	Strong
78-108	Bss2	10YR3/2	10YR3/1	3mabk	vh	vfi	vs,vp	Slickenslides	Strong
108-144	Bss3	10YR3/2	10YR3/1.5	3mabk	vh	vfi	vs,vp	Slickenslides	Strong
144-160	Bss4	10YR3/2	10YR3/1	3mabk	vh	vfi	vs,vp	Slickenslides	Strong
160-170	BC	10YR3/3	10YR3/2	3msbk	vh	vfi	vs,vp	-	Strong
Mararutti series (Basalt)									
0-19	Ap	7.5YR3/2	7.5YR2.5/2	2msbk	h	fi	s,p	-	Strong
Kolur series (Granite-gneiss)									
0-11	Ap	10YR3/3	10YR3/1.5	2msbk	h	fi	s,p	-	Moderate
11-62	Bw	10YR3/2	10YR3/2	3msbk	h	fi	s,p	-	Strong
62-97	Bss1	10YR3/2	10YR3/1	3mabk	h	vfi	vs,vp	Slickenslides	Strong
97-140	Bss2	10YR3/2	10YR3/1.5	3mabk	h	vfi	vs,vp	Slickenslides	Strong
140-150	BC	10YR3/2	10YR3/1.5	3msbk	vh	vfi	vs,vp	-	Strong

Table 2. Continued

Depth(cm)	Horizon	Color		Structure	Consistency			Special features	Effervesence
		Dry	Moist		Dry	Moist	Wet		
Black soils									
Heggapur series (Granite)									
0-18	Ap	10YR4/2	10YR3/2.5	2msbk	H	fi	s,p	-	Moderate
18-37	Bw	10YR4/2	10YR3/2.5	2msbk	H	fi	s,p	-	Moderate
37-48	Bss1	10YR3/3	10YR3/2	2mabk	H	vfi	vs,vp	Slickensides	Moderate
48-68	Bss2	10YR3/3	10YR3/2	2mabk	vh	vfi	vs,vp	Slickensides	Moderate
68-75	BC	10YR3/3	10YR3/2	2msbk	vh	vfi	vs,vp	-	Strong
Kalmala series(Granite)									
0-16	Ap	10YR3/3	10YR3/2	2msbk	sh	fi	ms,mp	-	Moderate
16-48	Bw	10YR3/3	10YR3/2	2msbk	h	fi	ms,mp	-	Moderate
48-66	Bss1	10YR3/2.5	10YR3/2	2mabk	h	vfi	vs,vp	Slickensides	Moderate
66-90	Bss2	10YR3/2.5	10YR3/2	3mabk	h	vfi	vs,vp	Slickensides	Strong
90-140	Bss3	10YR3/3	10YR3/2	3mabk	vh	vfi	vs,vp	Slickensides	Strong
140-150	BC	10YR3/3	10YR3/2	3msbk	vh	vfi	vs,vp	-	Strong
Naglapur series(Granite)									
0-14	Ap	10YR3/3	10YR3/2.5	2msbk	h	fi	s,p		Moderate
14-28	Bw	10YR3/3	10YR3/2.5	2msbk	h	fi	s,p		Moderate
28-52	Bss1	10YR4/2	10YR3/2	2mabk	h	vfi	vs,vp	Slickensides	Strong
52-75	Bss2	10YR4/2	10YR4/1.5	2mabk	vh	vfi	vs,vp	Slickensides	Strong
75-90	Bss3	10YR4/2	10YR4/1.5	2mabk	vh	vfi	vs,vp	-Slickensides	Strong
90-100	BC	10YR4/2	10YR4/2	2msbk	vh	vfi	vs,vp	-	Strong

Note:-Structure- 1: Weak, 2: Moderate, 3: Strong, m: Medium, abk: Angular Blocky, sbk: Sub Angular Blocky, Consistency- l: Loose, s: soft:vh: Very hard, sh: Slightly hard, fr: Friable, fi: Firm, vfr: Very friable, vfi: Very firm; s: Sticky, p: Plastic, ss: Slightly sticky, ms: Moderately sticky,sp: Slightly plastic, mp: Moderately plastic, so: Non sticky po:Non plastic, vs: Very sticky,vp: Very plastic

Table 2. Continued

Horizon	Depth	Clay	Soil texture	CEC	CEC/CLAY
	cm	%		Cmol (p+)kg^{-1}	
			Lateritic soils		
			Kurkota series		
Ap	0-12	22.66	GSCL	9.25	0.41
Bw1	12-32	23.93	GSCL	7.18	0.3
Bw2	32-61	26.25	GSCL	8.14	0.31
Bw3	61-97	29.97	GSCL	10.1	0.34
BC	97-110	29.05	GSCL	10.12	0.35
	SWA	**26.98**		**8.96**	**0.33**
			Bachanal series		
Ap	0-10	20.98	GSCL	6.5	0.31
Bw1	10-28	22.66	GSCL	7.03	0.31
Bw2	28-50	22.37	GSCL	7.01	0.31
BC	50-60	22.91	GSCL	6.53	0.29
	SWA	**22.32**		**6.85**	**0.31**
			Muttanga series		
Ap	0-15	34.66	GSC	11.09	0.32
Bw1	15-38	35.24	GSC	11.59	0.33
Bw2	38-85	37.7	GSC	11.69	0.31
Bw3	85-118	39.24	GSC	12.77	0.33
BC	118-150	40.33	GC	13.31	0.33
	SWA	**36.41**		**11.73**	**0.31**
			Badrapur series		
Ap	0-9	33.36	GSCL	10.68	0.32
BC	9-17	37.47	GSC	11.12	0.3
	SWA	**35.29**		**10.89**	**0.31**
			Kodambal series		
Ap	0-7	34.25	GSCL	12.9	0.38
Bw1	07-10	36.81	GSC	11.78	0.32
BC	10-15	38.21	GSC	11.98	0.31
	SWA	**36.09**		**12.37**	**0.34**

Horizon	Depth	Clay	Soil texture	CEC	CEC/CLAY
	cm	%		Cmol (p+)kg^{-1}	
Ap	0-12	28.78	GSCL	11.32	0.39
Bw1	12-32	33.72	GSCL	11.13	0.33
BC	32-48	35.72	GSC	12.14	0.34
	SWA	**33.15**		**11.51**	**0.35**

Table 2. Continued

Red soils					
Rummanagunda series					
Ap	0-15	28.49	GSCL	16.95	0.59
BC	15-24	26.2	GSCL	13.15	0.5
	SWA	**27.63**		**15.53**	**0.56**
Kalamandargi series					
Ap	0-12	31.32	GSCL	16.91	0.54
Bw1	12-25	32.14	GSCL	17.02	0.53
Bw2	25-43	33.27	GSCL	17.3	0.52
BC	43-50	32.65	GSCL	17.3	0.53
	SWA	**32.42**		**17.13**	**0.53**
Chatra series					
Ap	0-15	27.28	GSCL	15.73	0.58
BC	15-37	29.36	GSCL	15.38	0.52
	SWA	**28.52**		**15.52**	**0.55**
Thodki series					
Ap	0-15	33.28	GSCL	17	0.51
Bw1	15-35	35.23	GSC	17.26	0.49
BC	35-68	36.37	GSC	18.19	0.5
	SWA	**35.35**		**17.65**	**0.5**
Kallarahatti series					
Ap	0-8	27.2	GSCL	13.33	0.49
Bw1	8-15	28.69	GSCL	13.77	0.48
Bw2	15-20	30.15	GSCL	14.77	0.49
BC	20-25	28.97	GSCL	13.91	0.48

	SWA	**28.56**		**13.86**	**0.49**
Palkanmaradi series					
Ap	0-12	28.73	GSCL	14.94	0.52
Bw1	12-23	30.13	GSCL	15.37	0.51
Bw2	23-35	31.04	GSCL	16.14	0.52
Bw3	35-48	31.65	GSCL	16.77	0.53
Bw4	48-58	33.29	GSCL	17.64	0.53
Bw5	58-64	34.4	GSCL	18.23	0.53
BC	64-75	33.88	GSCL	18.3	0.54
	SWA	**31.63**		**16.63**	**0.53**

Table 2. Continued

Black soils					
Rajnal series					
Ap	0.-20	54.87	C	58.2	1.06
Bw	20-48	56.8	C	57.2	1.01
Bss1	48-78	60.7	C	58.36	0.96
Bss2	78-108	62.4	C	60.36	0.97
Bss3	108-144	64.9	C	62.45	0.96
Bss4	144-160	67.8	C	64.2	0.95
BC	160-170	64.5	C	63.33	0.98
	SWA	**61.45**		**60.21**	**0.98**
Margutti series					
Ap	0-19	47.69	GC	55.26	1.16
Kolur series					
Ap	0-11	57.7	C	53.74	0.93
Bw	11-62	58.1	C	52.35	0.9
Bss1	62-97	59.5	C	53.32	0.9
Bss2	97-140	61.3	C	55.94	0.91
BC	140-150	55.9	C	58.06	1.04
	SWA	**59.17**		**54.09**	**0.91**
Heggapur series					
Ap	0-18	43.8	C	54.6	1.25

Black soils					
Bw	18-37	46.1	C	51.3	1.11
Bss1	37-48	49.52	C	54.6	1.1
Bss2	48-68	53.78	C	58.1	1.08
BC	68-75	58.45	C	60.2	1.03
	SWA	**49.25**		**55.22**	**1.13**
Kalmala series					
Ap	0-16	47.5	C	49.04	1.03
Bw	16-48	49.54	C	46.08	0.93
Bss1	48-66	50.8	C	47.34	0.93
Bss2	66-90	54.89	C	51.43	0.94
Bss3	90-140	58.06	C	54.6	0.94
BC	140-150	55.48	C	52.02	0.94
	SWA	**53.57**		**50.64**	**0.95**
Nagalapur series					
Ap	0-14	43.25	GC	49.14	1.14
Bw	14-28	45.66	C	48.98	1.07
Bss1	28-52	47.91	C	51.63	1.08
Bss2	52-75	49.89	C	53.97	1.08
Bss3	75-90	52.69	C	57.27	1.09
BC	90-100	50.95	C	55.22	1.08
	SWA	**48.42**		**52.66**	**1.09**

3.3 Soil Structure

Dominant soil structure type was sub angular blocky throughout the solum in both red and lateritic soil series with exception to surface horizons of Badrapur, Mustari, Kurkota and Chatra series where it was granular and it could be attributed to higher organic matter content at surface of latter soils series and even in black soil series also dominant soil structure type was sub angular blocky in upper solum and angular blocky in lower solum and this could be attributed to formation of slickensides in lower solum due to the sliding of natural peds one over the other.

Soil structural grade was weak to moderate in red and lateritic soil series while in black soils it was moderate to strong and it could be attributed to both the quality and quantity of clay. Higher clay content as well as smectite group of clay as indicated by CEC/clay ratio in black soils could be attributed to their moderate to strong soil structural grade.

Soil structure class varied from fine to medium in both red and lateritic soils series and in black soils series it was medium and this could be attributed to dominance of fine active smectite group of clay as indicated by CEC/clay ratio facilitated more of soil aggregation in latter soil series and these findings are in agreement with Sitanggang et al. [10] and Vikas et al. [11].

3.4 Soil Consistency

Red and lateritic soils series registered slightly hard to hard dry consistency, friable to very friable moist consistency and slightly sticky and slightly plastic to moderately sticky and moderately plastic wet consistency in surface and sub surface horizons respectively where as in black soils series dry, moist and wet soil consistency varied from hard to very hard, firm to very firm and sticky and plastic to very sticky and very plastic in surface and sub surface horizons respectively and this could attributed to both quantity and quality of clay and similar results were reported by Walia and Rao [12];Pulakeshi et al. [13] and Rudramurthy et al. [14].

3.5 Other Morphological Features

Wider and deeper surface cracks, gilgai microrelief, wedge shaped structural aggregates and slickenslides in sub surface horizons of the all the black soils series were due to the predominance of smectite group of clay in the soils and similar kind of observations were reported by Rudramurthy et al. [15] in their studies on associated red and black soils derived from diversified parent materials namely granite, schist and basalt.

3.6 Soil Taxonomy

All black soils series derived from basalt, granite and granite-gneiss complex were classified as *Vertisols* at order level as they possessed slickensides in subsurface horizons, more than 30 per cent clay in all the horizons and open cracks up to a depth of 50cm and that were one cm wide and extended upward to the surface and these cracks remain open for more than 90 cumulative days during the year but not throughout the year. At sub order level these black soils series were classified as Usterts as they exhibited the cracks that open and close more than once during the year in most years and mean annual soil temperature was more than 22°C. At great group level all the black soils series were classified as *Haplusterts* as they did not possess calcic, gypsic or salic horizons. At subgroup level, all the black soils series other than Margutti series were keyed out as *Typic Haplusterts* as they conveyed the central concept of *Haplusterts*. Margutti soil series was keyed out as *Lithic Haplustert* at subgroup level as they pocessed lithic contact within 50 cm soil depth.

In spite of high clay content and clay illuviation, illuvial horizon did not fulfill the requirements of argillic horizon in both red and lateritic soils series and thus they were keyed out as *Inceptisol* at order level and at sub order level they were qualified for Ustepts as they possessed Ustic moisture regime and at great group level these soils were classified as *Haplustepts* as they possessed more than 60 per cent base saturation as well as appreciable amount of free $CaCO_3$ but did not posses either calcic, umbric or mollic horizons. At subgroup level all the lateritic soils series other than both Badrapur and Kodambal soil series were keyed out as *Typic Haplustepts* as they conveyed the central concept of *Haplustepts* and both Badrapur and Kodambal soil series were keyed out as *Lithic Haplustept* at sub group level as they pocessed lithic contact within 50cm soil depth while at subgroup level all the red soils series other than Kallarahatti and Rummanagunda soil series were keyed out as *Typic Haplustepts* as they conveyed the central concept of Haplustepts and

both Kallarahatti and Rummanagunda soil series were keyed out as *Lithic Haplustept* at sub group level as they pocessed lithic contact within 50cm soil depth and these results are in line with Vijay kumar et al. [16]; Chandrashekar et al. [17] and Mohekar et al. [18]; [19,20].

4. CONCLUSION

Based on morphological, physical and chemical properties, red and lateritic soils series other than Badrapur, Kodambal, Rummanagunda and Kallarahatti series were classified as *Typic Haplustepts* while Badrapur, Kodambal, Rummanagunda and Kallarahatti series were keyed out as *Lithic Haplustepts* at sub group level. All the black soils series other than Margutti series were classified as *Typic Haplusterts* while Margutti series was grouped under *Lithic Haplusterts* at sub group level.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. Soil Survey Staff. Keys to Soil Taxonomy (Ninth Edition), United States department of agriculture, natural resources conservation service, Washington D.C.; 2003.
2. Natarajan, A, Sarkar, D. Field guide for soil survey. NBSS&LUP, Nagpur: 2010;73.
3. Anonymous. Soil Survey Staff, Soil Survey Manual, Oxford and IBH publishing company, Calcutta. 1951;503
4. Bhaskar BP, Subbaiah GV. Genesis, characterization and classification of laterites and associated soils along the east coast of Andhra Pradesh. J. Indian Soc. Soil Sci. 1995;43(1):107-112.
5. Singh DP, Rathore MS, Morphological, physical and chemical properties of soils associated in toposequence for establishing taxonomy classes in Pratapgarh District of Rajasthan, India. African J. Agric. Res. 2015;10(25): 2516-2531.
6. Singh S. The formation of dark coloured clay-organic complex in black soils. J. Soil Sci. 1956;7:45-58
7. Basavaraju D, Naidu MVS, Ramavatharam N, Venkaiah K, Ramarao G, Reddy KS. Characterization and evaluation of soils in Chandragiri mandal of Chittoor district, Andhra Pradesh. Agropedology. 2005; 15:55-62.
8. Nagraj Rudramurthy HV, Rajesh NL, Satishkumar U, Vidyavathi GY. Properties, genesis and classification of soils developed on diversified parent materials in selected area of Budhihal micro-watershed (4D7A312F) in Yadgir district, Karnataka, India. Int. J. Chem. Studies., 2018;6(3):2380-2386
9. Praveen. Characterization and assessment of soil quality and evaluation of its productive potential to pigeon pea crop in selected benchmark soil series of Kalyana Karnataka region. M.Sc.(Agri) Thesis, Univ. Agric. Sci., Raichur, Karnataka, India; 2022.
10. Sitanggang M, Rao YS, Ahmed N, Mahapatra SK. Characterization and classification of soils in watershed area of Shikohpur, Gurgaon district, Haryana. J. Indian Soc. Soil Sci. 2006;54:106–110.
11. Vikas NK, Kumar KA, Kalaiselvi B. Soil characterisation and classification of Gollarahatti-2 watershed, Karnataka, India. Advances in Res. 2018;16(5):1-12.
12. Walia CS, Rao YS. Genesis, characteristics and taxonomic classification of some red soils in Bundelkhand region of Uttarpradesh. J. Indian Soc. Soil Sci. 1996;44(3):476- 481.
13. Pulakeshi HBP, Patil PL, Dasog GS. Characterization and classification of soil resources derived from chlorite schist in northern transition zone of Karnataka. Karnataka J. Agric. Sci. 2014; 27(1):14-21
14. Rudramurthy HV, Basavaraj K, Chinchmalatpure AR. Geomorphic site analysis to study soils developed on a toposequence of schist landform in Yadgir district of Karnataka. J. Indian Soc. Soil Sci. 2016;64(1):25-32.
15. Rudramurthy HV, Dasog GS, Vasuki N, Pedogenicfeatures of red and black soils developed from dharwar rock system. J. Maharashtra Agric. Uni.1997;22:147-150.
16. Vijaya Kumar T, Reddy MS, Gopalakrishna V. Characteristics and classification of soils of northern Telangana zone of Andhra Pradesh. Agropedology. 1994;4:31-43.
17. Chandrasekhar C, Naidu MVS, Ramprakash T, Balaguravaiah D. Genesis, characterization and classification of soils from selected parts of Prakasam district in Andhra Pradesh, India. J. Pharmaco. Phytochem. 2019;8(1): 51-58.

18. Mohekar DS, Singh SK, Chattaraj S, Ramamurthy V, Srivastava R. Characterization and classification of soils on quartzite-schistose landscape in tropical ecosystem of Goa–in a Topo-sequence. Int. J. Curr. Microbiol. App. Sci. 2020;9(06): 228-241.
19. Soil Survey Staff, Soil Survey Manual. Handb. U.S. Dept. Agric. 1951;18:167-168.
20. Soil Survey Staff. Soil Taxonomy-A basic system of soil classification for making and interpreting soil surveys. 2nd Eds. Agricultural Hand Book No. 436, United States Department of Agriculture, Washington, D. C., USA; 2009.

Peer-review history:
The peer review history for this paper can be accessed here:
https://www.sdiarticle5.com/review-history/112585