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PHYSICO-CHEMICAL CHARACTERISTICS OF MAJOR SOILS IN SOLLAPURA SUB-WATERSHED OF CHIKMAGALUR DISTRICT IN KARNATAKA

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Abstract

The soil chemical characteristics of Sollapura sub-watershed of Chikmagalur district in Karnataka have been studied. The study revealed that the soils are deep to very deep, light yellowish brown to dark red, well to poorly drained, slightly acidic to moderately alkaline, low to high in organic carbon and low to medium in cation exchange capacity with wide textural variations. The soils on gently sloping topography exhibit the development of argillic horizon (Bt). The soils have been classified as Alfisols soil order. On the basis of the major soil constraints, sustainable land use plan for the micro-watershed has also been suggested for their better management and crop production.

Key words: Alfisol, Watershed, Soil classification land use, Cambic horizon, Argillic horizon

Introduction

Land and water are the most vital natural resources of the country and these are under tremendous stress due to ever increasing biotic pressure. Proper management of these resources with minimum adverse environmental impact is essential, not only for sustainable development but also for human survival. This decline was attributed to periodic droughts, poor management and exploitative agriculture coupled with soil degradation processes. The potential of land for crop production to satisfy the demand for the ever increasing population is declining as a result of severe soil degradation.

Watershed is a "geo-hydrological" entity or piece of land that drains at a common outlet. This natural unit is evolved through the interaction of the rainwater and land mass and normally comprises of arable and non-arable lands along with drainage lines. Thus, the watershed area is delineated based on distribution and flow of rainwater, which facilitates scientific developments of natural resources like soil, water and vegetation.

Land Resource Inventory and mapping are plays a vital role in natural resource management. It assists to planning land use, particularly agriculture, because it assesses the land resource and its potential for sustainable agricultural production. Assessing of soil resources, in case of variable properties like physical, chemical and biological which results showed that the success in soil management to maintain soil quality (Wakene, 2001). This implies that understanding the characteristics of soils is prerequisite for designing appropriate management strategies thereby solving many challenges faced in crop and livestock production sectors and in their efforts towards natural resource conservation and management for sustainable development. Keeping these factors in mind the study has been undertaken to characterize and classify the soils of Sollapura sub-watershed and to suggest the land use plan to protect the natural resources for sustainable crop production.

Materials and Methods

The study area Sollapura sub-watershed is located in Chikmagalur district of Karnataka state. Chikmagalur district is situated in the Malenadu region of Karnataka in the Deccan Plateau in the foothills of the Western Ghats. It lies in the south central part of Karnataka,

between 12° 54' 42" - 13° 53' 53" N latitudes and 75° 04' 46" - 76° 21' 50" E longitudes, with a geographical area of 7201 km^2. The district comprises of 7 taluks of which Tarikere comes under southern transition zone No.7 and rest of the taluks comes under Hilly Zone No.22. Tarikere is located at 13.72°N 75.82°E. It has an average elevation of 698 metres (2290 feet). Tarikere borders 3 taluks in its own district. The mean annual rain fall varies from lowest 600 mm in Kadur taluk to more than 4000 mm in Sringeri taluk. Sollapura sub watershed is covering four mini-watersheds *viz*. Mallenhalli-1 (674 ha), Mallenhalli-2 (546 ha), Sollapura (661 ha) and Tommaladdhalli (566 ha) in Tarikere taluk of Chikmagalur distinct. Location map is given in fig. 1.

The detailed morphological description of these fourteen pedons was studied as per the procedure outlined in soil survey manual (Soil Survey Staff 2003). The soil samples representing each horizon of the pedons were collected and characterized for important physical and physico-chemical properties using standard procedures. The soil samples collected from the control section (25 to 100 cm) of each pedon were analysed by sedimentation technique (Jackson 1973). The soils were classified according to Keys to Soil Taxonomy (Soil Survey Staff 2003). Considering limitations and potentials of the soils, land capability classification was evaluated upto sub-class level (Klingebiel and Montgomery 1966) and based on that a suitable land use plan has also been suggested.

Results and Discussion

Morphological characteristics

Seven soil series *viz*. Balliganur, Nagadevanahalli, Thimmapura, Koranahalli, Tadaga, Hanumapura and Aldahalli are coming under Alfisols soil order. Varying soil morphological characteristics are soil depth shallow (<50 cm) to very deep (>150 cm). The soils had colours in the hue of 10YR to 5 YR. The colour grades to redder hues with depth. The values ranged between 1 to 3 and chromas between 3 to 6 (table 1). Schwertman and Taylor (1977) believed that 5YR colours might be due to the presence of both lepidocrocite and ferrihydrite. Childs and Wilson (1983) proved that haematite was associated with 5YR colours while goethite with 7.5YR and 10YR colours. Free iron oxides played an important role in imparting red color to soil. The soil horizons had single grain structure and weak to moderate, fine to medium and granular to sub-angular blocky structures with soft to slightly hard (dry) and loose to friable (moist) consistence. The bottom layers were grading from weak to moderate, fine to medium subangular blocky structure and soft to hard (dry) and friable to firm (moist) in consistence. Low clay content and type of clay mineral are responsible for the consistence in red soils (Sehgal *et*

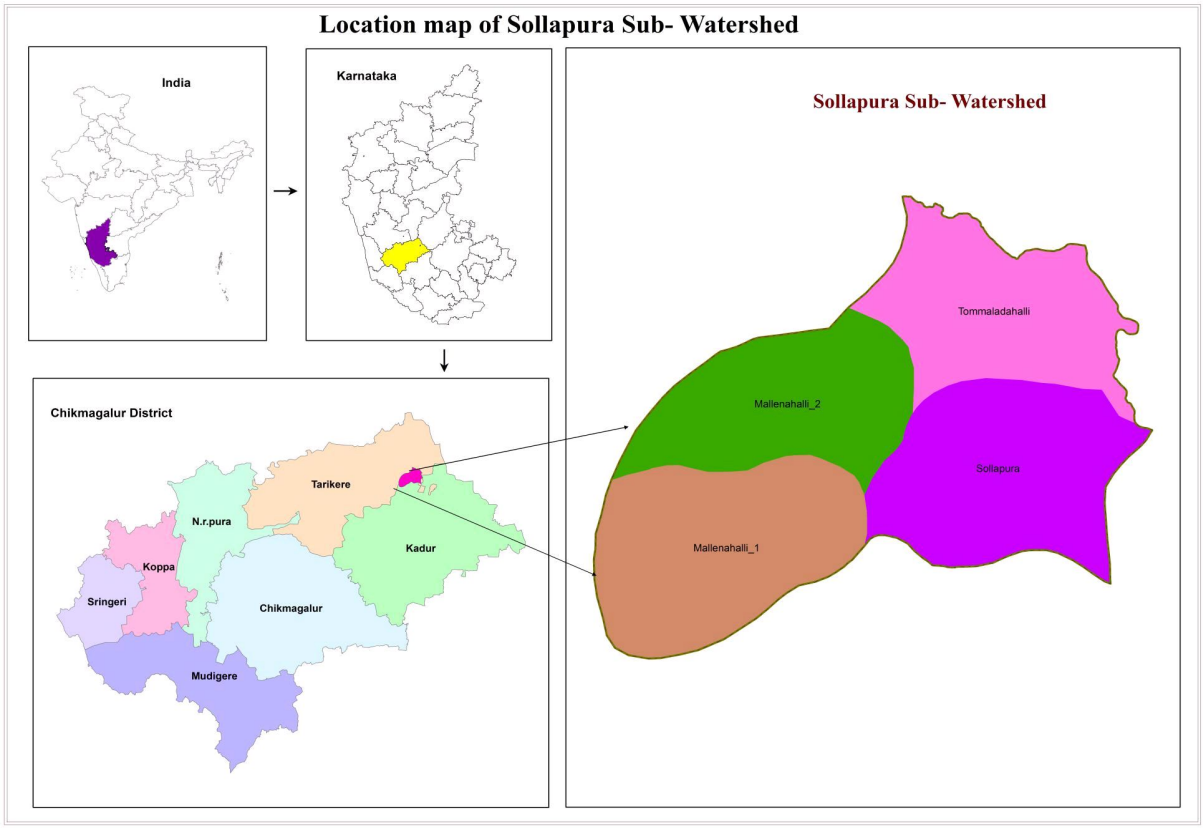

Fig.1: Location of Sollapura sub watershed

Table 1: Morphological and physical characteristics of the soils

Depth (cm)	Horizon	Colour (Moist)	Sand (2.0-0.05) (mm)	Silt (0.05-0.002)	Clay (<0.002)	Texture	WHC (%)	Structure	Consistency
								S G T	D M W
Balliganur series									
0-13	Ap	7.5YR 4/4	41.2	16.0	42.7	c	44.6	f 2 sbk	sh fr s/p
13-34	BA	7.5YR 3/3	45.2	18.8	35.9	sc	37.9	f 2 sbk	- fr s/p
34-59	Bt1	5YR 3/4	40.7	17.7	41.5	c	43.0	f 2 sbk	- fr s/p
59-83	BC	5YR 5/6	48.9	15.0	36.1	sc	39.2	m 2 sbk	- fr s/p
Nagadevanahalli series									
0-15	Ap	10YR 4/3	62.5	27.5	10.0	sl	24.9	f 2 sbk	sh fr ns/np
15-35	BA	10YR 4/6	68.2	16.7	15.0	sl	29.2	f 2 sbk	- fr ns/np
35-56	Bt1	10YR 4/3	60.0	17.5	22.5	scl	32.6	m 2 sbk	- fr ss/sp
56-79	Bt2	10YR 3/6	52.1	10.4	37.5	sc	39.7	m 2 sbk	- fr ss/sp
79-97	Bt3	10YR 3/6	47.5	14.4	38.1	sc	36.0	m 2 sbk	- fr ss/sp
Thimmapura series									
0-25	Ap	5YR 3/4	54.0	19.5	26.5	scl	30.8	m 2 sbk	sh vfr ss/sp
25-66	Bt1	5YR 3/3	9.75	42.2	48.0	sc	54.6	m 2 sbk	- fr s/p
66-95	Bt2	5YR 3/3	44.0	18.5	37.5	sc	39.8	m 2 sbk	- fr s/p
95-106	Bt3	5YR 3/4	41.0	7.25	51.7	c	52.5	m 2 sbk	- fr s/p
Koranahalli series									
0-12	Ap	10YR 3/2	77.3	7.50	15.0	sl	26.1	f 2 sbk	sh fr vs/vp
12-43	Bt1	10YR 3/1	57.9	7.10	35.0	sc	38.3	m 2 sbk	- fr vs/vp
43-65	Bt2	10YR 3/1	54.9	12.5	32.5	sc	34.0	m 2 sbk	- fr vs/vp
65-99	Bt3	5YR 3/3	39.9	12.5	47.5	c	61.4	f 2 sbk	- fr ms/mp
99-141	Bt4	7.5YR 4/3	37.5	17.5	45.0	c	59.1	f 2 sbk	- fr ms/mp
Tadaga series									
0-13	Ap	7.5YR 4/4	49.7	32.7	17.5	sl	29.5	f 1 sbk	sh fr so/po
13-41	Bt1	5YR 3/4	46.2	11.0	42.7	sc	46.9	m 2 sbk	- fr s/p
41-75	Bt2	5YR 3/4	46.0	6.5	47.5	sc	41.3	f 1 sbk	- fr s/p
Hanumapura series									
0-13	Ap	5YR 4/4	61.5	17.5	21.0	scl	25.6	f 2 sbk	sh fr ss/sp
13-26	Bt1	5YR 4/4	56.5	10.4	33.1	scl	43.5	m 2 sbk	- fr ms/mp
26-41	Bt2	2.5YR 3/4	51.5	9.5	39.0	sc	40.3	m 2 sbk	- fr ss/sp
Aldahalli series									
0-18	Ap	7.5YR 4/4	55.0	18.8	26.2	scl	32.5	m 1 sbk	sh fr ss/sp
18-38	Bt1	7.5YR 4/4	40.2	14.2	45.5	c	39.4	m 2 sbk	- fr s/p
38-81	Bt2	5YR 3/4	41.5	17.7	40.7	c	43.5	m 2 sbk	- fr s/p
81-100	Bt3	5YR 3/4	38.5	20.2	41.2	c	40.2	m 2 sbk	- fr s/p
100-170	BC	5YR 3/4	43.2	14.5	42.2	c	41.9	m 2 sbk	- fr s/p

al., 1987).

Physical characteristics

The per cent coarse fragments increased with depth in all major soils. The coarse fragments were mainly quartz gravel in all the soils (table 2). Medium deep and deep soils had insignificant amount of gravels (10-60%) in B horizons of Balliganur and Nagadevanahalli series. The sand content is varied between 9.7 to 77.3 per cent, the per cent sand decreasing with depth and clay content ranged from 10.0 to 51.7 per cent which is increased with different depths. This can be partial attribution of vertical migration of clay and translocation of clay from the surface to lower horizons (Torrent *et al.,* 1980; Klich *et al.,* 1990). The surface enrichment of sand fraction is due to the removal of finer particles by clay eluviation and surface runoff. Water holding capacity of soils in different location is varied based on clay content. The WHC of the soils ranged between 24 to 61 per cent. These differences were due to the variation in the depth, clay, silt and organic carbon content of the pedons. These results are in line with those of Thangaswamy *et al.*

Table 2: Physico-chemical characteristics of the soils

Depth (cm)	Horizon	pH (1:2.5) H_2O	EC (dS m^{-1})	OC (%)	Exchangeable cations				CEC	K_2O (kg ha^{-1})
					Ca	Mg	Na	Sum of cations		
					(1 N NH40Ac, pH 7.0)					
					< ——— cmol (p+) kg-1 ——— >					
Balliganur series										
0-13	Ap	7.55	0.34	0.68	9.25	4.50	0.39	14.14	15.18	184
13-34	BA	8.31	0.40	1.20	17.2	6.75	0.51	24.46	26.39	395
34-59	Bt1	8.50	0.42	1.38	19.0	9.20	0.55	28.75	31.22	372
59-83	BC	8.68	0.44	1.47	23.0	10.7	0.58	34.28	35.25	345
Nagadevanahalli series										
Ap	0-15	6.99	0.14	0.49	8.50	3.75	0.38	12.63	13.3	241
BA	15-35	7.16	0.25	0.60	9.50	4.25	0.32	14.07	15.1	274
Bt1	35-56	7.20	0.18	0.64	8.50	4.75	0.37	13.62	22.5	308
Bt2	56-79	7.02	0.15	0.58	8.30	4.20	0.29	12.79	14.9	252
Bt3	79-97	7.39	0.18	0.69	10.0	4.75	0.33	15.08	16.7	277
Thimmapura series										
Ap	0-25	6.25	0.02	0.42	9.50	4.75	0.27	14.52	15.1	188
Bt1	25-66	6.13	0.02	0.51	9.50	7.75	0.26	17.51	18.1	182
Bt2	66-95	5.34	0.01	0.36	8.25	5.25	0.22	13.72	14.1	118
Bt3	95-106	4.52	0.02	0.48	3.75	2.25	0.19	6.19	6.6	124
Koranahalli series										
Ap	0-12	7.28	0.03	0.66	11.2	5.50	0.38	17.08	19.8	425
Bt1	12-43	6.94	0.06	0.57	9.0	3.50	0.30	12.80	14.1	329
Bt2	43-65	6.26	0.05	0.21	7.0	3.25	0.28	10.53	14.0	399
Bt3	65-99	7.62	0.07	0.84	11.0	4.25	0.40	15.65	18.1	340
Bt4	99-141	7.49	0.07	0.51	10.7	5.50	0.44	16.64	21.2	289
Tadaga series										
Ap	0-13	4.94	0.04	0.44	7.75	4.50	0.20	12.45	12.9	146
Bt1	13-41	5.11	0.03	0.36	9.75	5.50	0.20	15.45	15.9	175
Bt2	41-75	5.77	0.04	0.55	10.7	8.50	0.30	19.50	20.2	197
Hanumapura series										
Ap	0-13	5.45	0.04	0.42	4.95	2.30	0.30	7.55	9.10	147
Bt1	13-26	5.60	0.05	0.53	5.25	2.75	0.34	8.34	10.3	174
Bt2	26-41	6.11	0.06	0.58	6.80	3.20	0.35	10.35	12.9	155
Aldahalli series										
Ap	0-18	6.17	0.18	0.51	8.00	4.75	0.29	13.04	16.96	192
Bt1	18-38	6.56	0.20	0.57	9.75	5.00	0.33	15.08	14.54	230
Bt2	38-81	6.67	0.12	0.66	7.25	4.50	0.41	12.16	13.89	253
Bt3	81-100	6.81	0.24	0.72	8.75	5.25	0.38	14.38	17.67	313
BC	100-170	6.86	0.25	0.78	9.55	4.20	0.40	14.15	15.64	336

(2005) in soils of Sivagiri watershed in Chittoor district of Andhra Pradesh.

Chemical characteristics

There was a general trend of increasing pH with depth in all the pedons. All the soil series are range of strongly acidic (<5.5) to neutral (6.5 -7.5) except Balliganur series are slightly alkaline (7.5-8.5) to strongly alkaline (>8.5). The lower pH values in subsoil, indicate the high degree of development of the soil from acid parent materials (Shrikant *et al.,* 1993). The electrical conductivity values ranged between 0.01 and 0.44 dS m^{-1} indicating that the soils are non saline. Organic carbon content was found to decrease with depth. Organic carbon followed irregular distribution in all the series, it may due to transported soil materials. Organic carbon content ranged from 0.21 to 0.84 percent but high in Balliganur series (0.68-1.47%) respectively, which in general accumulated in surface layers. The lower

Table. 3 Major soil series and family level classification

Sl. No	Soil Series	Alfisols Family level classification
1	Balliganur (BNR)	Fine- skeletal, mixed, isohyperthermic, Typic Haplustalfs
2	Nagadevan-ahalli (NDH)	Fine loamy-skeletal, mixed, isohyperthermic, Typic Haplustalfs
3	Thimmapura (TIM)	Fine, mixed, isohyperthermic, Typic Haplustalfs
4	Koranahalli (KOR)	Fine, mixed, isohyperthermic, Vertic Haplustalfs
5	Tadaga (TAD)	Fine-skeletal, mixed, isohyperthermic, Kanhaplic Haplustalfs
6	Hanumapura (HNM)	Fine-skeletal, mixed, isohyperthermic, Kandic Paleustalfs
7	Aldahalli (ALD)	Fine, mixed, isohyperthermic, Typic Kanhaplustalfs

contents of organic carbon apparently resulted because of high temperature which might have induced its rapid oxidation. Observations in the line with the present findings have been reported by Basavaraju *et al*. (2005). The cation exchange capacity (CEC) values varied from 6.6 to 35.2 cmol (p+) kg^{-1} in different soils, overall low content, it may due to leaching of cations from surface soils and influence of primary minerals (Buol *et al.,* 1998). Exchange complex was mostly saturated with Ca^{2+} followed by Mg^{2+}, Na^{+} and K^{+}. This order of abundance was in accordance with Jenny's (1941) view that the leaching caused preferential losses of Na^{+} and K^{+}. Higher values of exchangeable Ca and Mg indicated the decrease in extractable magnesium content in soils. Soil Classification

Based on morphology and soil properties, the soils were classified according to Keys to Soil Taxonomy (Soil Survey Staff 2003) into the order Alfisols. The seven soil series showed the presence of argillic (Bt) sub-surface diagnostic horizon as evidenced by the fact that the illuvial horizon contains 1.2 times more clay than the eluvial horizon and also had base saturation more than 35% throughout the profile. However, these pedons were classified as Ustalfs at sub-order lever due to the presence of ustic soil moisture regime (table 3).

Conclusions

The study of morphological, physical and physico-chemical analysis of soil samples revealed that the red soils of Sollapura sub-watershed were slightly acidic to moderately alkaline in soil reaction, non-saline and low to high in organic carbon content. Further CEC was also low to medium and exchange complex was dominated by Ca^{2+}. The soils of sub-watershed were classified upto sub-group level. Based on the soil properties suitable land use plan has to suggested for sustaining crop production in watershed.

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