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Research article

STUDIES ON PHYSICAL, CHEMICAL AND AMORPHOUS CONSTITUENTS OF ASSOCIATED RED AND BLACK SOILS: A CASE STUDY IN HATTI SCHIST BELT OF NORTH KARNATAKA

M Harshitha[1], S L Budhihal[2], C Prathyusha[3] and G Amrutha veena[4]

Department of Soil Science and Agricultural Chemistry, University of Agricultural Sciences, Raichur – 584 102, Karnataka, India

ABSTRACT: Associated red and black soils of the transect from Hira region of Hatti schist belt were studied for their properties. Soils were moderately deep to deep, reddish brown (5YR 3/4) to dark black (10YR3/2), clay in texture. The pH ranged from 7.56 to 7.7, EC from 0.4 to 0.44dSm^{-1}, low to medium in organic carbon, moderate in CEC (40.1 – 54.3 c mol (p+) kg^{-1}). Free iron oxides ranges from (0.6-3.2%), Na_2CO_3 extractable free silicon ranges from (0.4-3.1%) and Na_2CO_3 extractable free aluminium ranges from (0.2 - 2.5%).

Key words: Associated red and black pedons, free iron, silicon, aluminium oxides.

INTRODUCTION

Associated red and black soils are most common in the Deccan Plateau of India and about 10 per cent of the total geographical area of India is covered by these soil complexes (Anonymous, 1987).Topography which determines the drainage conditions helps in formation of red soils in crest and piedmont, whereas black soils are formed at foot slopes, valleys and depressions where the formation of smectite clays is favoured (Desai, 1942).In the Hira area of the Hatti schist belt of North Karnataka, an inverted occurrence of red and black soil association was found. In this area, the black soils are on the crest whereas the red soils occupy the slopes and lower plains. The landform selected for the study is the Hira area in the Hutti-Maski belt in North Karnataka. It comprises of associated red and black pedons differing in their morphological, physical and chemical characteristics.

MATERIALS AND METHODS

The sequence of soils of this transect, i.e. black soils- brown soils can be said as inverted association of red and black soils. For the purpose of the present study, the soils of the transect were studied by opening a selected pedon and sampling the soil horizons.The soil samples representing each horizon of the pedons were collected and characterized for important morphological (colour, texture, structure, consistency, roots and boundary) and physico-chemical properties like pH (1:2.5), EC(1:2.5), OC and $CaCO_3$ (Jackson 1967), particle size distribution by international pipette method (Piper 1966), exchangeable cations and CEC (Jackson 1967),CBD-extractable Iron oxides (Mehra and Jackson, 1960),Silica and aluminium (sodium carbonate extractable).

RESULTS AND DISCUSSION

Morphological properties

The colour of the black soil pedon was dark black (10YR 3/2),might be due to the clay humus complex in the presence of lime as indicated by Singa *et al.* (1998), brown soil pedon had 5YR 3/2 and appears to be due to high content of brown iron oxides as indicated by Rudramurthy and Dasog (2001). The structure designates the mode of arrangement of the particles and their aggregates. Therefore the structural variation in soils was useful to differentiate the horizon. Structure was moderate sub-angular blocky in black soil pedon and this appears to be due to swell shrink nature. Whereas in brown had weak sub-angular blocky and the weak structural development might be due to fine particulate nature of inert iron oxides. The consistence of black soil pedon varies from very hard to extremely hard when dry and and very sticky and very plastic when wet, whereas that for brown soil horizons, hard to very hard, when dry, friable when moist, slightly sticky to very sticky and slightly plastic to very plastic when wet. The black pedon had characteristic cracks and slickensides. But the brown soil pedon did not have cracks and slickensides. (Table-1).

Table 1.Morphological features of the pedons

Horizon	Depth (cm)	Colour		Texture*	Structure*	Salient morphological features
		Dry	Moist			
Hira black Soil						
Ap	0 - 20	10YR3/1	10YR3/2	c	2c sbk	Pressure faces on ped surface
A2	20 - 35	10YR2/2	10YR3/1	c	2m sbk	Slickensides on ped surface
A3	35 - 60	10YR3/1	10YR3/2	c	2c abk	Slickensides on ped surface
A4	60 - 75	10YR3/2	10YR3/1	c	3m abk	
Hira brown soil						
Ap	0 - 15	5YR3/3	5YR3/1	c	1m sbk	
BA	15 - 45	5YR3/2	5YR3/2	c	2c sbk	
Bt1	45 - 67	5YR3/2	5YR3/1	c	2f sbk	Presence of lime mycilia in Bt1and 2Bt2
2Bt2	67 - 97	5YR2/2	5YR2/1	c	3f abk	
Hira red Soil						
Ap	0-20	2.5YR 3/4	2.5YR ¾	sc	1m sbk	Presence of parent material

* c – clay, sc – sandy clay * c – coarse, m – medium, f – fine , sbk – sub angular blocky, abk – angular blocky

Chemical properties

In the black and brown soil pedon, the pH which was neutral to slightly alkaline indicating impeded leaching of bases uniformly throughout the depth, both the black and brown soil pedons were non saline, EC ranges from 0.4 to 0.44 dSm^{-}1. The organic carbon content of all the three soil pedons varied from 0.5 to 0.7. In all the pedons the organic carbon content decreased with the depth and is naturally expected as the organic residues are added to the surface only. The organic carbon content was more in black soils than in the brown soil. This may be due to the higher organic carbon content, might be due to the presence of clay- humus complexes in black soil than in brown soil (Ray chaudhuri *et al.*, 1942). Brown pedon showed less free calcium carbonate values when compared to black pedon and the difference appears to be due to the difference in the leaching conditions of these soils. The values of free calcium carbonate was more in the sub surface horizons compared to surface horizons and was due to the movement of calcium as soluble calcium bicarbonate to the lower horizons and precipitate as calcium carbonate in the lower horizons as explained by Kulakarni *et al*, (1963). (Table-2)

Table 2. Textural and chemical properties of the soils

Horizon	Depth (cm)	Coarse sand	Fine sand	Total sand	Silt	Clay	Textural class	pH (1:2.5)	EC dSm-1	Organic carbon (%)	CaCO 3 (%)
		<--------- % of the fine earth---------------->									
Hira black soil											
Ap	0 - 20	7	13	20	35	45	c	7.7	0.40	0.7	13
A2	20 - 35	6	12	18	31	51	c	7.69	0.42	0.6	14
A3	35 - 60	6	9	15	30	55	c	7.62	0.43	0.5	15
A4	60 - 75	5	10	15	24	61	c	7.68	0.44	0.4	15
Hira brown soil											
Ap	0 - 15	9	21	30	22	48	c	7.65	0.42	0.6	7
BA	15 - 45	7	20	27	20	53	c	7.57	0.40	0.4	8
Bt1	45 - 67	6	14	20	25	55	c	7.59	0.43	0.33	7
2Bt2	67 - 97	7	15	22	20	58	c	7.56	0.44	0.3	9
Hira red soil											
Ap	0 - 20	16	12	28	35	37	c	7.69	0.47	0.5	5

Exchangeable cations and CEC

Black and brown pedons showed high CEC values ranges from 40 to 54 cmol (p+) kg^{-1}. The cation exchange capacity (CEC) was significantly and positively correlated with clay content (Sharma and Anil Kumar, 2003). The base saturation in the black and the brown soils was also higher (91 to 96%) throughout the depth. The exchangeable bases in all the pedons were in order of $Ca^{++} > Mg^{++} > Na^{+} > K^{+}$ on the exchange complex. In the black and the brown soils exchangeable Ca^{++} ranges from 21.3 to 38.1 cmol (p+) kg^{-1} and it is the dominant cation on the exchange complex. This is due to more calcic nature of both the soils. In the black soil, the CEC/ clay ratio ranges from 0.8 to 1.0 and in the case of brown soil from 0.8 to 0.9, indicating the predominance of smectite clay minerals (Table-3).

Table 3. Exchangeable properties of pedons

Horizon	Depth (cm)	Exchangeable bases				CEC	Base saturation (%)	(Ex.Ca+++ Mg++) / (Ex. Na+ + K+)	CEC/ Clay
		Ca^{++}	Mg^{++}	Na^{+}	K^{+}				
		---------------------cmol (p+)/kg-------------------							
Hira black soil									
Ap	0 - 20	22.9	20.2	0.51	0.54	48.6	91	41	1.0
A2	20 - 35	21.3	17.4	0.53	0.51	42.5	94	37	0.8
A3	35 - 60	32.2	14.2	0.7	0.6	52.2	92	36	0.9
A4	60 – 75	38.1	11.4	0.5	0.4	54.3	93	55	0.9
Hira brown soil									
Ap	0 - 15	22.0	14.6	0.5	0.6	40.1	95	33	0.8
BA	15 - 45	24.6	13.3	2.2	0.4	43.3	94	15	0.8
Bt1	45 - 67	31.4	12.9	0.8	0.4	48.5	94	37	0.9
2Bt2	67 – 97	35.4	13.2	0.7	0.4	52.5	95	44	0.9
Hira red soil									
Ap	0 – 20	16.7	9.2	0.5	0.4	32.2	84	29	0.8

Amorphous constituents of the soils

In the black soil, the free iron content ranges from 0.6 to 0.9 % and in the brown soil it ranges from 2.6 to 3.2%. The higher iron oxides content in the brown soil might be due to higher degree of weathering and leaching of bases, leading to the accumulation of iron oxides as explained by Sathyanarayana and Biswas (1970). In the case of black soil and brown soil pedon Na_2CO_3 extractable free silicon ranges from 0.5 to 3.1% and the free silicon content increases with depth in both the black and the brown soils. It might be due to the movement of silica down and accumulation at the lower layers. Black soils had higher free silica content than that of red soils and this might be due to differences in leaching. In the case of black soil and brown soil pedon the Na_2CO_3 extractable free aluminium ranges from 0.2 to 2.5% and the content of free aluminium was more in black soil, again owing to differences in leaching. (Table-4).

Table 4. Amorphous constituents of the soils

Horizon	Depth (cm)	Sodium carbonate extractable		CBD extractable Fe (%)
		Si	**Al**	
		---------- % ------------		
Hira black soil				
Ap	0 - 20	2.2	2.2	0.9
A2	20 - 35	2.6	2.5	0.8
A3	35 - 60	2.8	1.2	0.6
A4	60 - 75	3.1	1.5	0.9
Hira brown soil				
Ap	0 - 15	0.5	0.3	3.2
BA	15 - 45	0.6	0.2	2.6
Bt1	45 - 67	0.8	0.4	3.1
2Bt2	67 - 97	0.9	0.2	3.0
Hira red soil				
Ap	0 – 20	0.4	0.3	1.9

CONCLUSION

The chemical properties such as free iron oxides, Na_2CO_3 extractable free silica and aluminium maybe used to differentiate their formations. In case of black soil, free silicon and aluminium have accumulated whereas in brown soils the free iron oxides were higher, probably due to difference in leaching conditions. Even when the soils are formed from the same parent material, the differences in other external factors, such as leaching may result in the formation of different soils, which appears to explain the occurrence of this association of black and red soils in the Hira region of the Hatti schist belt of North Karnataka.

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