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Characterization of physico-chemical properties of red soil (Alfisol) in Mirzapur District of Utter Pradesh

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Abstract
The paper deals with physic-properties of red soil in Mirzapur district of Utter Pradesh. The red soil classified in to two groups like sandy red and gravel red soil. Five profile studies of different places of Mirzapur. Mirzapur district is situated in the southern part of Uttar Pradesh. It is located between 25.8° N to 25.15° N latitude and 82.34° E to 82.58° E longitude covering an area of 4952.5 km^2. These soils were mainly spread the unconsolidated rock, slopes and eroded trains in the semi-arid area. The terrain in Mirzapur District is hard rocky and the soils are residual, well-drained entisols and alfisols, derived from recent alluvium and Kaimur sandstones (Dhandraulorthoquartzites). The highest mean values of red sandy soil of physio-chemical properties like, pH, EC, TOC, Carbon stocks, and Exchangeable base (cmol (p+)kg^{-1}) Ca, Mg, in the soil profile depth (0-100 cm) were 7.21, 0.17, 0.22, 27.09, 4.79 and 5.49.

Keywords: Carbon stocks, exchangeable base, EC, PH etc

Introduction
Soil is one of the most important resources of the nature. All living things depend on plants, and plants grow in soil for day to day need. Soils are medium in which crop grows to food and cloth. Soil is not only important for agriculture but also have more useful for living organisms. The composition of clastic sedimentary rocks is a function of several variables, such as the source material, weathering, transportation, physical sorting and diagenesis. Geochemistry of clastic sedimentary rocks has proven to be a useful tool in the study of the provenance, tectonic setting and palaeo climatic conditions of ancient sedimentary rocks especially of Archaean and Proterozoic sediments. It has also provided constraints on the composition and evolution of the atmosphere, hydrosphere, and continental crust through time (D. J. Wronkiewicz *et al*, 1987). The Vindhyan basin is the largest (presently exposed area 104,000km2) of the Precambrian sedimentary basins. It comprises a thick (4000m in the thickest parts) sequence of largely unmetamorphosed and undeformed succession of shales, sandstones, limestones, dolostones with subordinate, felsic volcanics and volcaniclastics (Mistra *et al*, 2012). Red soil is a type of soil that develops in a warm, temperate, moist climate under deciduous or mixed forest, having thin organic and organic-mineral layers overlying a yellowish-brown leached layer resting on an illuvial red layer (Bell 2009) [2]. Red soils are generally derived from crystalline rock (Krasilnikov P *et al*, 2013) [10]. They are usually poor growing soils, low in nutrients and humus and difficult to cultivate because of its low water holding capacity (Roy, *et al*, 2006) [20]. This soil, also known as the omnibus group, have been developed over Archaean granite, gneiss and other crystalline rocks, the sedimentaries of the Cuddapah and Vindhayan basins and mixed Dharwarian group of rocks (Chadurvedy, 2011). Their colour is mainly due to ferric oxides occurring as thin coatings on the soil particles while the iron oxide occurs as haematite or as hydrous ferric oxide, the colour is red and when it occurs in the hydrate form as limonite the soil gets a yellow colour. Ordinarily the surface soils are red while the horizon below gets yellowish colour.

Material and method
Mirzapur district is situated in the southern part of Uttar Pradesh and is located between 25.8° N to 25.15° N latitude and 82.34° E to 82.58° E longitude covering an area of 4952.5 km^2.

Table 1: Sample location

Soil Type	Location	Longitude(E°)	Latitude(N°)	Soil Order
Red sandy soil	Halia	82.32739	24.83017	Alfisols
	Lalganj	82.36833	25.01007	
	Bheri	82.85324	25.05642	
Red gravelly soil	Ranibhari	82.86041	25.13471	Alfisols
	Parsia	82.59534	25.04681	

Method of soil collection and preparation

To collect a soil sample, surface litter was gently scrapped off with a khurpi. A rectangular pit was dug to a depth of 1 m. Soil samples were collected from the wall of the rectangular pit using stainless steel auger from a depth of 0-5, 5-15, 15-30, 30-60 and 60-100 cm. In addition, to measure the bulk density, cores measuring 5 cm in length and 5 cm in diameter were used. Soil samples were dried in shade and brought to the laboratory where they were ground to pass a 2 mm sieve, tagged and stored in plastic containers for analysis.

Analysis of samples

The soil ph and electrical conductivity (EC) were recorded in 1:2.5 Soil to water suspension (Jackson, 1973). Exchangeable bases were collected using neutral normal ammonium acetate and the exchanged ion measured following procedure outlined in Hesse (1970). The total Ca^{++} and Mg^{++} was determined by complexometric titration, involving ethylene diamine tetra acetic acid (EDTA). Total organic carbon content of the soils were determined by the method of Yeomas and Bremmer (1988) after treating the soil with dilute acid. In this method one gram of soil was oxidized with 5 ml of $1N K_2Cr_2O_7$ and 7.5 ml conc. H_2SO_4 utilizing external heat (170 °C for 30 minutes). Carbon stocks were determined using the formula,

$$Carbon\ Stock = \frac{TOC \times BD \times D \times 10{,}00}{100}$$

Where Carbon Stock is $Mgha^{-1}$, TOC is the Total Organic organic carbon expressed as Mg 100 Mg^{-1}, BD id bulk density in Mgm^{-3} and D is depth of soil in m. (Mg- Mega gram)

Result and discussion

Physico - chemical properties of red sandy soils.

Three soil profiles were studied to represent young alluvial soils of Mirzapur, namely Halia, Lalganj and Bheri (Table 2 and plat 1, 2, 3). The red sandy soils were all acidic to alkaline in reaction. Soils of Halia were acidic to neutral in reaction at all soil depths. The pH was 5.80 in the surface and increased to 7.0 at lower depth (60-100 cm). Soils of Lalganj was neutral to slightly alkaline in reaction, varying in pH between 7.3 to 8.1. The soils of Bheri were generally neutral to slightly alkaline in reaction (Respectively Sauza et, al 2014). The surface soil of Bheri was neutral (pH 6.8) and it increased to pH 7.80 down the profile. The overall trend in pH of sandy red soils were that they were acidic (pH 5.80) to slightly alkaline (pH 8.10) in reaction.

The electrical conductivity of the Halia soil profile was low and varied from 0.07 to 0.23 dSm^{-1}. The EC of Lalganj varied between 0.09 to 0.16 dS m^{-1} and was also low. The EC of the Bheri soil profile decreased with increasing depth from 0.80 dS m^{-1} in the 0-5 cm depth to 0.09 dSm^{-1} at 60-100 cm depth. Higher EC in surface soils is probably due to addition of salts in the form of fertilizers. The overall EC in the red sandy soils of Mirzapur ranged from 0.07 to 0.80 dSm^{-1}, which is non-saline. Hence there is no warning on growth of all types of crops in these soils.

The red sandy soils of Mirzapur had in general low organic carbon levels with the exception of surface soil layer of Langanj which had medium level of organic carbon (0.52%). The organic carbon content varied between 0.07 to 0.23% in Halia; 0.05 to 0.52% in Lalganj and 0.08 to 0.47% in Bheri. In all the soil profiles, organic carbon content decreased with soil depth (Karmar *et al*, 2008).

The exchangeable Ca content in Halia profile varied between 6.30 to 8.05 cmol (+) kg^{-1} whereas the Mg content varied between 5.45 to 6.60 cmol (+) kg^{-1}. There was enough calcium and magnesium content in soil to support plant growth (Walker *et al*, 1995) [23]. The exchangeable Ca content in Lalganj was varied between 1.70 to 4.30 cmol (+) kg^{-1}, whereas the magnesium content varied between 1.70 to 6.75 cmol (+) kg^{-1}. The exchangeable magnesium content in Bheri was more than the calciuim content thought the profile. The calcium content varied between 2.40 to 5.70 cmol (+) kg^{-1} whereas the magnesium content varied between 3.00 to 7.80 cmol (+) kg^{-1}.

The carbon stocks in Halia profile varied between 2.75 to 9.14 $Mgha^{-1}$, and highest found 30-60 cm depth of soil profile due to high organic carbon present this depth. Lalaganj highest carbon stock found in 5-15 cm depth of soil profile and varied between 4.15 to 6.32 $Mgha^{-1}$ and lowest in the 60-100cm depth. And Bheri soil profile was the carbon stocks varied between 2.89 to 8.23 $Mgha^{-1}$ and highest found in 5-15 cm depth and lowest is 0-5 cm depth of soil. The total sum of carbon stocks highest found in Lalaganj soil profile (25.96 $Mgha^{-1}$).

Physico- chemical properties of red gravelly soil soils.

Three soil profiles were studied to represent young alluvial soils of Mirzapur, namely Ranibhari and Parsia (Table 3, Plate 4, and 5). The red gravelly soils were all acidic to neutral in reaction. Soils of Ranibhari were acidic at all soil depths and neutral in reaction in 60-100 cm soil depth. The pH was 5.80 in the surface and increased to 7.2 at lower depth (60-100 cm). the pH was acidic in the plough layer (pH between 6.20-6.3) and neutral at lower depths (15-100 cm). The overall trend in pH of gravely red soils were that they were acidic to neutral (pH 5.80) to neutral (pH 7.30) in reaction (Mtama, 2015) [15].

The red gravelly soils were all non-saline and EC varied between 0.06 to 0.22 dS m^{-1}, which is non-saline. The EC of Parsia varied between 0.09 to 0.22 dS m^{-1} and 0.01-0.40 dS m^{-1} in Ranibhari. Oxidizable organic carbon was low in all the soil samples of Ranibhari and Parsi soil profiles except the surface soil of Parsia soil profile, which was in the medium range. The variation was between 0.01 and 0.40% in Ranibhari and 0.05 and 0.52% in Parsia.

The exchangeable Ca content in Ranibhari profile varied between 5.05 to 6.65 cmol (+) kg^{-1} whereas the Mg content varied between 5.20 to 5.85 cmol (+) kg^{-1}. There was enough calcium and magnesium content in soil to support plant growth. The exchangeable Ca content in Parsia was similar to that of Ranibhari and varied between 5.75 to 7.55 cmol (+) kg^{-1}, whereas the magnesium content varied between 1.05 to 5.05 cmol (+) kg^{-1}. The carbon stocks in Parsia profile varied between 3.59to7.92 $Mgha^{-1}$, and highest found 5-15 cm and lowest 0-5 cm depth of soil profile due to high total organic carbon present this depth. Ranibhari highest carbon stock found in 5-15 cm depth of soil profile and varied between 6.82 to 63.27 $Mgha^{-1}$ and lowest in the 0-5 cm depth of soil profile. The total sum of carbon stocks highest found in Lalaganj soil profile (164.82 $Mgha^{-1}$).

Table 2: Physico- chemical properties of red sandy soils of Mirzapur district.

Location	Depth (cm)	PH	EC (dSm^{-1})	Organic carbon (%)	Carbon stocks ($Mgha^{-1}$)	Exchangeable ($cmol(p+)kg^{-1}$) base	
						Ca	Mg
	0-5	5.8	0.23	0.35	3.03	6.30	5.45
	5-15	6.6	0.07	0.16	2.37	7.10	5.55
Halia	15-30	6.9	0.11	0.18	4.31	7.75	6.50
	30-60	6.8	0.10	0.16	9.14	8.05	6.60
	60-100	7	0.09	0.04	2.27	7.95	5.70
Range					Sum.		
	Max	7.00	0.23	0.35	21.12	8.05	6.60
	Min	5.80	0.07	0.04		6.30	5.45
Mean		6.62	0.12	0.17		7.43	5.96
	0-5	7.4	0.15	0.52	4.69	1.70	4.40
	5-15	7.3	0.16	0.42	6.32	2.80	3.60
Lalganj	15-30	7.7	0.14	0.22	6.17	4.30	1.70
	30-60	8.1	0.10	0.08	4.62	3.25	6.75
	60-100	7.5	0.09	0.05	4.18	3.90	6.15
Range					Sum.		
	Max	8.10	0.16	0.52	25.98	4.30	6.75
	Min	7.30	0.09	0.05		1.70	1.70
Mean		7.60	0.13	0.26		3.19	4.52
	0-5	6.8	0.80	0.33	2.89	2.40	3.00
	5-15	7.3	0.20	0.47	8.86	2.70	4.80
Bheri	15-30	7.5	0.13	0.13	3.27	3.10	7.20
	30-60	7.7	0.11	0.11	6.43	4.90	7.20
	60-100	7.8	0.09	0.08	5.64	5.70	7.80
Range					Sum.		
	Max	7.80	0.80	0.47	27.09	5.70	7.80
	Min	6.80	0.09	0.08		2.40	3.00
Mean		7.42	0.27	0.22		3.76	6.00
Range							
	Max.	8.10	0.80	0.52		8.05	7.80
	Min.	5.80	0.07	0.04		1.70	1.70
S. D.		0.58	0.18	0.16		2.20	1.72
Mean		7.21	0.17	0.22		4.79	5.49
Median		7.30	0.11	0.16		4.30	5.70

Table 3: Physico- chemical properties of gravel red soils of Mirzapur district.

Location	Depth (cm)	pH	EC (dSm^{-1})	Organic carbon (%)	Carbon stocks ($Mgha^{-1}$)	Exchangeable base ($cmol(p+)kg^{-1}$)	
						Ca	Mg
	0-5	5.8	0.18	0.40	6.82	5.05	5.20
	5-15	6.1	0.17	0.20	14.89	5.40	5.85
Ranibhari	15-30	6.4	0.14	0.11	27.35	6.30	5.45
	30-60	6.2	0.08	0.03	52.49	6.65	5.45
	60-100	7.2	0.06	0.01	63.27	5.60	5.55
Range					Sum.		
	Max	7.20	0.18	0.40	164.82	6.65	5.85
	Min	5.80	0.06	0.01		5.05	5.20
Mean		6.34	0.13	0.15		5.80	5.50
	0-5	6.3	0.22	0.52	3.59	5.75	2.00
	5-15	6.2	0.20	0.43	7.91	6.15	1.05
Parsia	15-30	6.8	0.18	0.26	7.27	7.15	2.25
	30-60	6.9	0.12	0.12	6.10	7.40	2.85
	60-100	7.3	0.09	0.05	3.88	7.55	5.05
Range					Sum.		
	Max	7.3	0.22	0.52	28.74	7.55	5.05
	Min	6.20	0.09	0.05		5.75	1.05
Mean		6.70	0.16	0.28		6.80	2.64
Range							
	Max.	7.30	0.22	0.52		7.55	5.85
	Min.	5.80	0.06	0.01		5.05	1.05
S. D.		0.50	0.05	0.18		0.87	1.81
Mean		6.52	0.14	0.21		6.30	4.07
Median		6.35	0.16	0.16		6.23	5.13

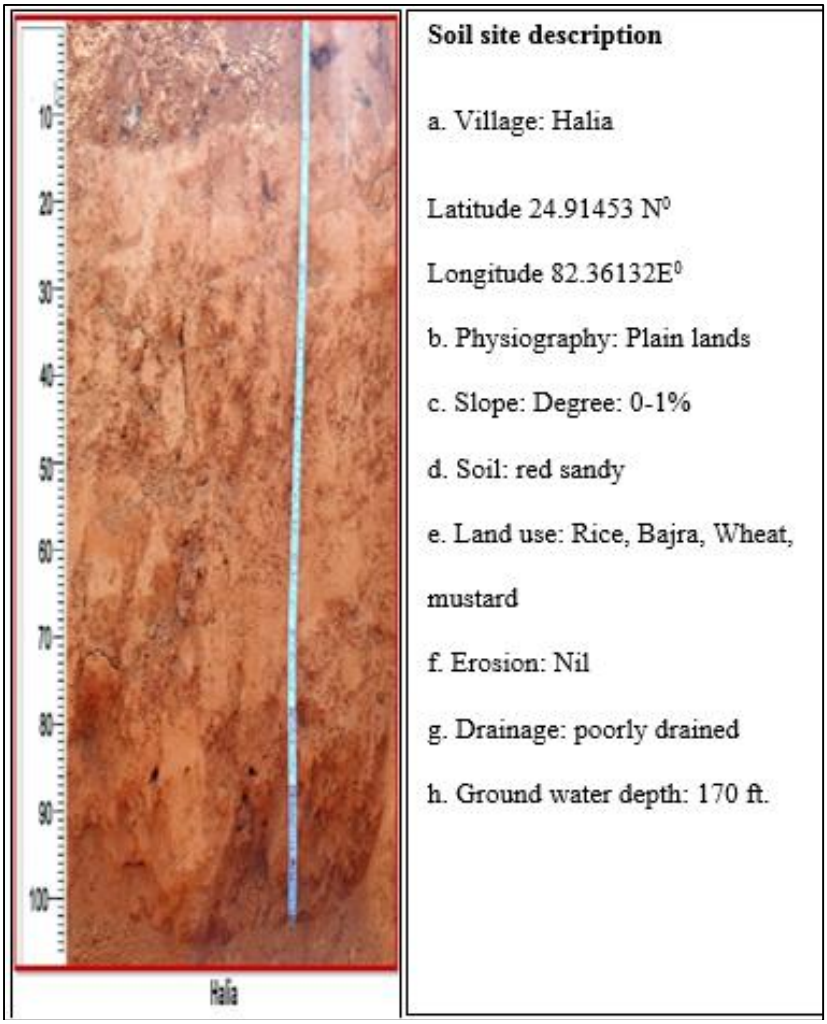

Plate 1: Profile halia

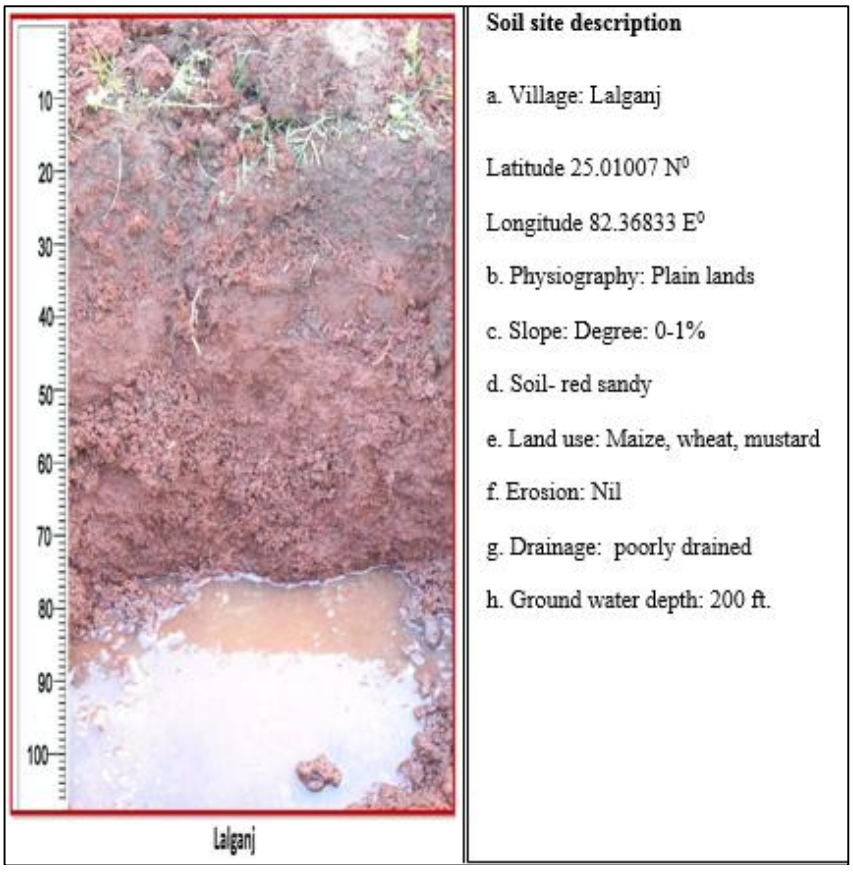

Plate 3: Profile Bheri

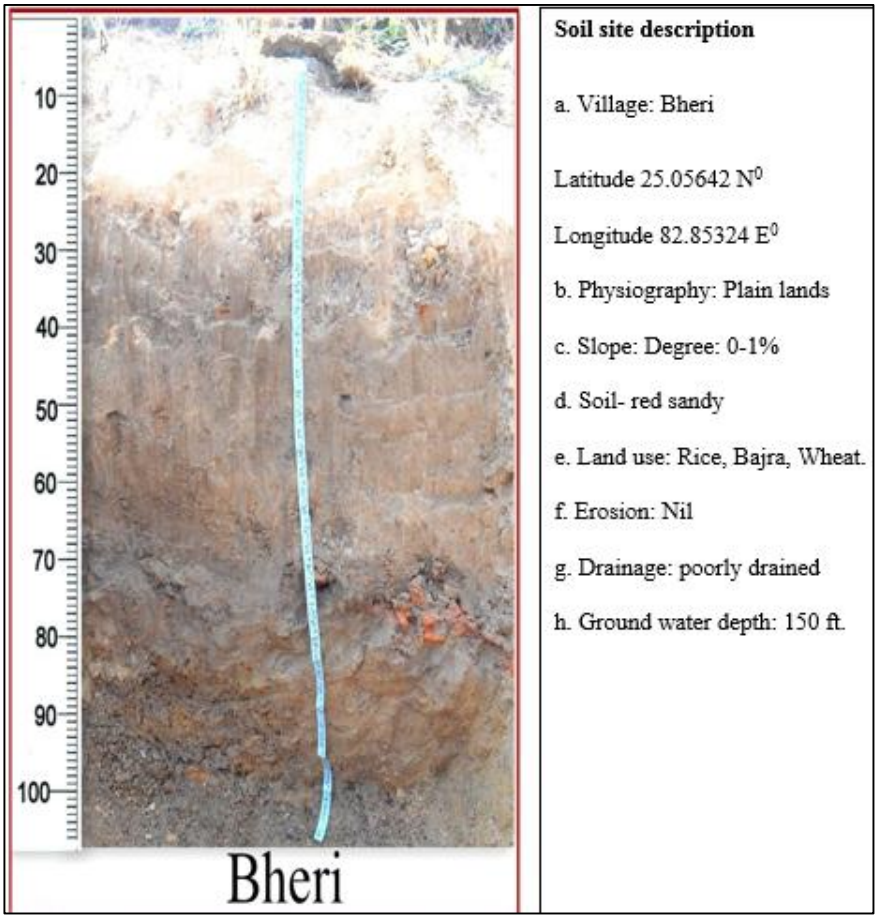

Plate 4: Profile Ranibari

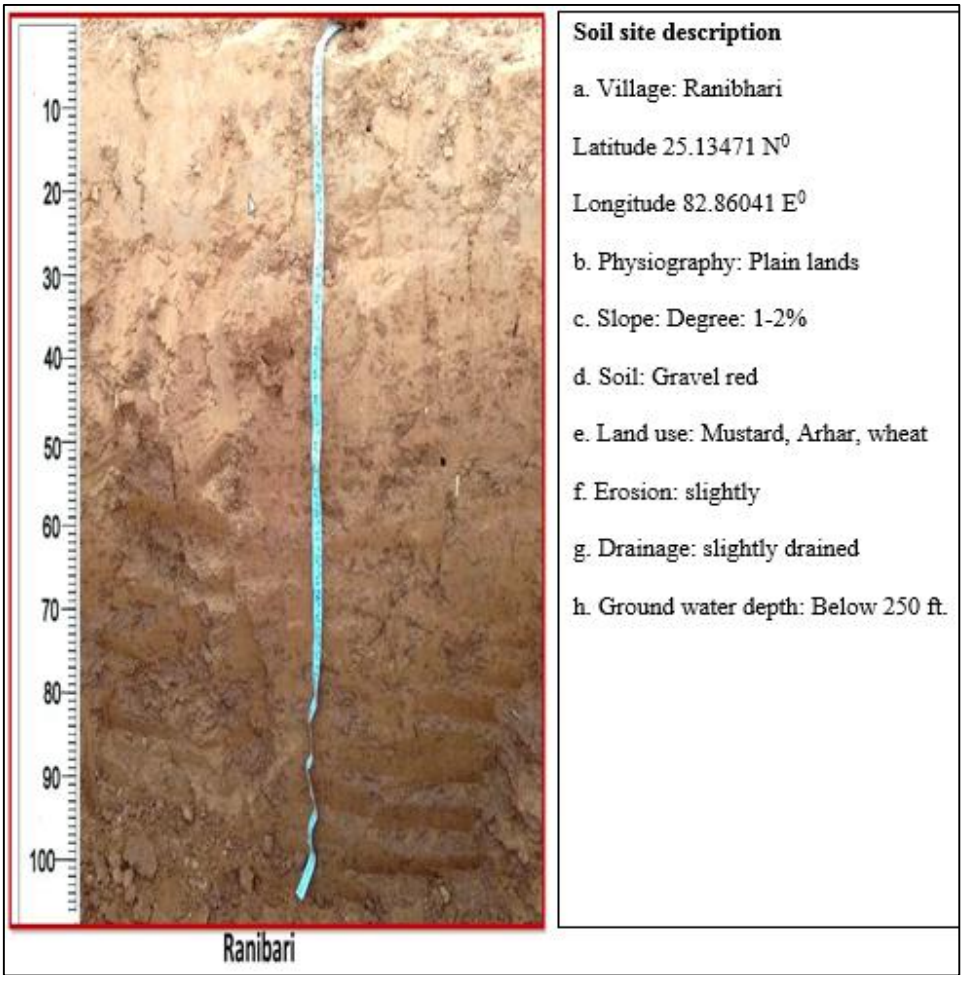

Plate 5: Profile Parsia

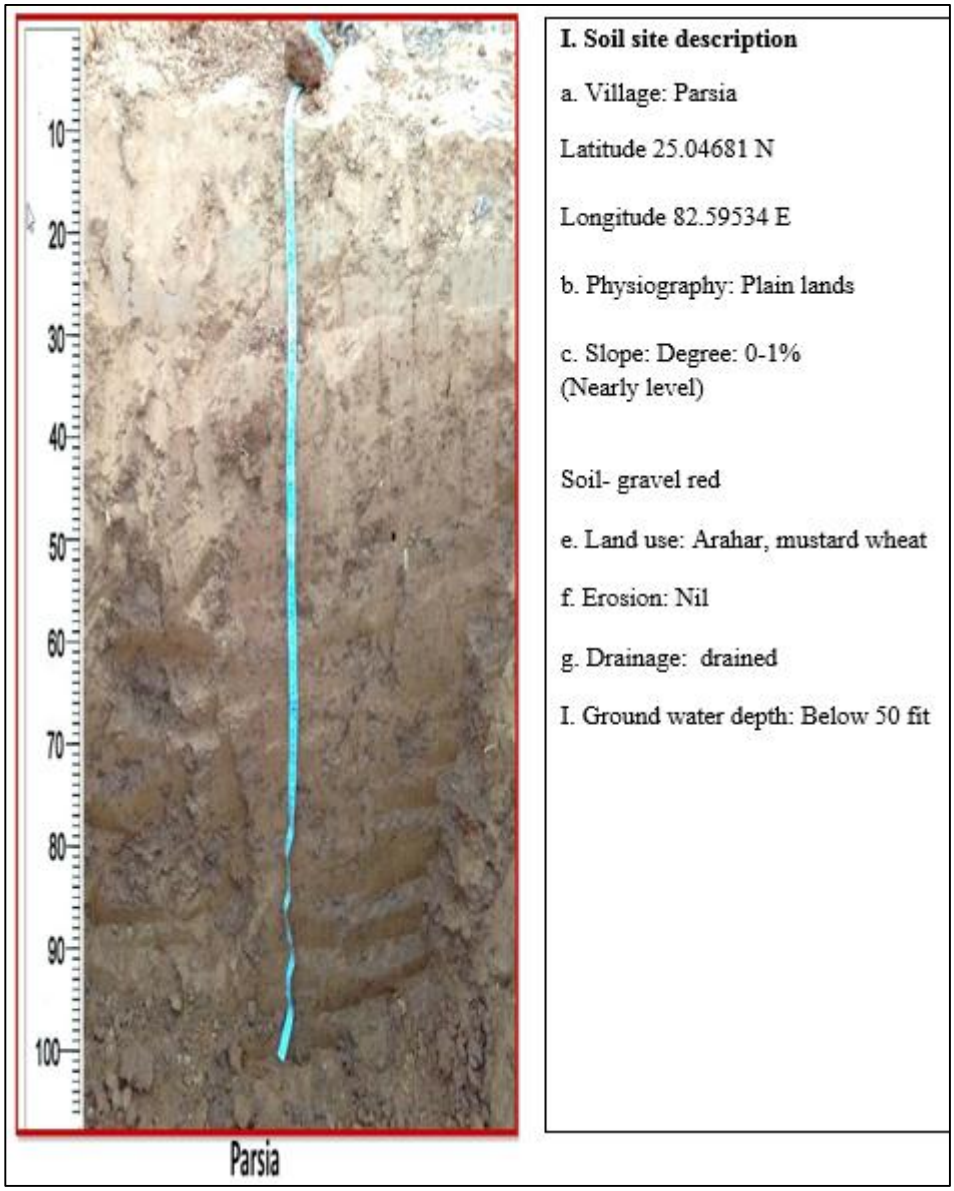

Plate 6: Profile Ptehra

Conclusion

Red sandy soils

Red sandy soils were cover large part of the district in the central and southern parts of the district and represented by soil profiles dug at Halia, Lalganj and Bheri. The red sandy soils were all acidic to alkaline in reaction. Soils of Halia were acidic to neutral in reaction at all soil depths. The electrical conductivity of all the soil profiles was low. The organic carbon levels were also low with the exception of surface soil layer of Langanj which had medium level of organic carbon (0.52%). The organic carbon content varied between 0.07 to 0.23% in Halia; 0.05 to 0.52% in Lalganj and 0.08 to 0.47% in Bheri. The overall carbon stocks highest found the Lalganj soil profile 25.8 $Mgha^{-1}$. The exchangeable Ca and Mg content were sufficient in these soils.

Red gravelly soils

The red gravelly soils were all acidic to neutral in reaction with low electrical conductivity. The oxidizable organic carbon was generally low and varied between 0.01 and 0.40% in Ranibhari and 0.05 and 0.52% in Parsia. The overall carbon stocks highest found the Ranibhari soil profile 164.6 $Mgha^{-1}$. There was enough cationic micronutrient in the whole soil profile.

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