International Journal of Chemical Studies

P-ISSN: 2349-8528
E-ISSN: 2321-4902
IJCS 2018; 6(6): 2936-2942
www.chemijournal.com

Received: 02-10-2018
Accepted: 09-11-2018

Tirath Das Sahu
Department of Soil Science and Agricultural Chemistry, Indira Gandhi Krishi Vishwavidyalaya, Raipur, Chhattisgarh

Ravi Shankar Nag
Department of Soil Science and Agricultural Chemistry, Indira Gandhi Krishi Vishwavidyalaya, Raipur, Chhattisgarh, India

Correspondence
Tirath Das Sahu
Department of Soil Science and Agricultural Chemistry, Indira Gandhi Krishi Vishwavidyalaya, Raipur, Chhattisgarh, India

Characterization of soils of different agro-climatic zones of Chhattisgarh

Tirath Das Sahu and Ravi Shankar Nag

Abstract
The present investigation was carried out to study the morphological and physicochemical characteristics of different soil profiles of Chhattisgarh and classify them. Nine pedons belonging to different agro-climatic zones of Chhattisgarh were studied for morphological and physico-chemical characteristics during summer season of 2006. Soil profiles were studied for depth, colour, texture, structure and consistency. Horizon wise soil samples were collected and analysed for mechanical composition, pH, EC, organic C and CEC. Out of nine soils studied, Nardaha soil of Chhattisgarh plain, Madpal and Kachnar soils of Bastar plateau were shallow. Phunderdihari soil of Northern hills zone, Banrasi soil of Chhattisgarh plain and Chokar soil of Bastar plateau were moderately deep while the Rajpuri soil of Northern hills zone, Darba and Jora soils of Chhattisgarh plain were deep with well-developed horizons. Shallow soils were coarser while deep soils were finer in texture. Soil colour varied from light red in Nardaha soil of Chhattisgarh plain through reddish brown in soils of Bastar plateau, yellowish brown in soils of Northern hills zone to light olive brown in Jora soil of Chhattisgarh plain. Moderate, medium and sub angular blocky structure (2, m, sbk) was common in all the pedons and almost all the horizons of the profiles in three agro-climatic zones. Wet consistence of soils varied from slightly-sticky, non-plastc (ss, po) in Madpal and Kachnar soils of Bastar plateau through slightly sticky, slightly plastic (ss, sp), sticky and plastic (s, p) in Northern hills zone to very sticky and very plastic (vs, vp) in Jora soil of Chhattisgarh plain. All the soils belonging to Northern hills zone and Bastar plateau and Nardaha soil of Chhattisgarh plain were acidic (pH < 6.0) in soil reaction while the soils of Banrasi, Darba and Jora belonging to Chhattisgarh plain were in the normal range. Salt content in these soils were in the safe limit for crops. All the soil of different agro-climatic zones were low in respect of organic carbon content except Chokar soil of Bastar plateau and Jora soil of Chhattisgarh plain which were in the lower margin of medium category. Acidic soils were having low CEC as compared to normal soils. Nardaha soil of Chhattisgarh plain and Madpal and Kachnar soils of Bastar plateau were classified as Lithic *Ustorthents*, Phunderdihari soil of Northern hills zone, Banrasi soil of Chhattisgarh plain and Chokar soil of Bastar plateau as Typic *Hapluestepts*, Rajpuri soil of Northern hills zone and Darba soil of Chhattisgarh plain as Typic *Haplustalfs*, and Jora soil of Chhattisgarh plain as Typic *Hapluesterts* at subgroup level.

Keywords: Morphological, physicochemical, soil classification, agro-climatic zone

Introduction
The most important basic natural resource that determines the ultimate sustainability of any agricultural system is the soil. The inherent ability of soils to supply nutrients for crop growth and maintenance of soil physical conditions to optimize crop yields is the most important component of soil fertility that virtually determines the productivity of agricultural system. A thorough and proper understanding of morphological, physical and chemical characteristics of the soils gives greater insight of the dynamics of the soil. Soil is an independent, dynamic body of nature that acquires properties in accordance with the forces which act upon it (Bear 1964) [1]. The important soil forming factors such as parent material, climate, relief, organism and time have direct impact on soil properties. The soil forming processes as oxidation, reduction, eluviation and illuviation are related to soil solution and further on stages of soil development. (Tamgadge *et al.* 2003) [17]. Chhattisgarh is situated in central eastern part of India. In the north of the state are the mighty Satpura Ranges, in the center the plains of river Mahanadi and its tributaries and in the south is the plateau of Bastar. The climate of Chhattisgarh state, in general, is sub-humid type and it receives annual rainfall ranging from less than 1200 mm to greater than 1600 mm in different areas with an average rainfall of about 1400 mm. Undulating topography and large variations in slope are the characteristic features of this region. Agro-climatically, Chhattisgarh may be divided into three distinct zones namely

Chhattisgarh plains (comprising of Raipur, Mahasamund, Dhamtari, Durg, Rajnandgaon, Kabirdham, Bilaspur, Korba, Janjgir districts, and part of Kanker and Raigarh districts), Bastar Plateau (Bastar, Narayanpur, Dantewada and Bijapur districts and remaining part of Kanker district) and Northern hill region (Surguja, Koriya, Jashpur districts and remaining part of Raigarh district). There is considerable variability in soil characteristics under different agro- climatic zones. The soils of Chhattisgarh plain belong to Entisols (Bhata), Inceptisols (Matasi), Alfisols (Dorsa) and Vertisols (Kanhar) orders. The Bastar plateau contains Mollisols in addition to the above soil orders and Alfisols are most abundant. The soils of northern hills have not been well studied in respect of their properties. The soils, however, are commonly described as eroded hilly soils, Goda/Tikra soils (light textured), Goda Chawar and Bahra soils in low-land (Subba Rao *et al.* 2001) [14]. Mixed red and black soils are found in Chhattisgarh plains and Northern hills zone of Chhattisgarh. Red and lateritic soils occur mainly in Bastar plateau with some patches in Chhattisgarh plains and in Northern hills zone. The red and yellow soils are mainly spread over the Chhattisgarh plains and northern hills zone of Chhattishgarh.

Materials and Methods

Location of Study Area

Nine pedons were studied for morphological, physical and chemical properties in different agro-climatic zones of Chhattisgarh. Of these, two pedons belonged to Northern hills zone, four in Chhattisgarh plain and three in Bastar plateau. The study area lies between 19º 05' to 23º 09' N latitude and 81º 38' to 83º 14'E longitude. Location of study area is shown in the map of Chhattisgarh state (Figure 1) and details of the study sites is presented in Table 1.

Climate of the Region

Northern Hills Zone of Chhattisgarh: Northern hill zone receives precipitation through South-west monsoon from June to September. The average annual precipitation is in the range of 1200 to 1600 mm. normally the monsoon in the region starts by the second week of June and withdraws during third week of September in the entire zone. Major amount of rainfall is received during the month of July and August. The climate of zone is considered as sub-humid which is mild in September and moderate to cool in winter. The day temperature generally varies from 23 ºC (January) to 41º C (May) and night temperatures varies from 4 ºC (January) to 26 ºC (May). The length of growing period varies from 150 to 180 days. Soil remains dry from December to May/June suggesting *Ustic* soil moisture regime. The mean annual soil temperature remains higher than 22° C qualifying for *Hyperthermic* soil temperature regime.

Chhattisgarh Plain: The region experiences hot sub- humid climate and receives annual rainfall of 1200-1600 mm. However, distribution of rainfall is not uniform and it is mostly concentrated in the month of June to September. Very little amount of rainfall is received during October - May. As such, the area qualifies for *Ustic* soil moisture regime. The length of growing period varies from 150 to 180 days. The mean annual soil temperature remains higher than 22°C qualifying for *Hyperthermic* soil temperature regime.

Bastar Plateau: The climate of the area is hot sub-humid with hot summers and cool winters. The area receives an annual rainfall of 1000-1600 mm. There is a prolonged dry period from December to May. As such, the area qualifies for *Ustic* soil moisture regime and *Hyperthermic* soil temperature regime. The length of growing period varies from 150 to 180 days and may sometimes extend.

Study of Morphological Characteristics

Soil profiles at the mentioned sites were exposed to a depth limited to lithic/paralithic contact or 1.5 m and were studied for depth, colour, texture, structure and consistency as per Soil Survey Staff (1999) [13]. Horizon wise soil samples were collected for laboratory analysis.

Study of Physico-chemical Properties

The bulk soil samples collected from the soil horizons of the soil profiles were allowed to dry in the air and then prepared for the physico-chemical analysis in the laboratory. A wooden mortar and pestle was used to crush soil aggregates to pass a 2 mm sieve. The processed soil samples were analysed in the laboratory for mechanical composition, pH, electrical conductivity, organic carbon and cation exchange capacity following standard methods and procedures. Soil pH was measured by glass electrode pH meter in 1:2.5 soil water suspensions after stirring of 30 minutes as described by Jackson (1973) [8]. The soil samples used for pH determination were allowed to settle down the soil particles for 24 hours. The conductivity of supernatant liquid was determined by conductivity meter as described by Jackson (1973) [8]. Organic carbon was estimated by wet digestion method of Walkley and Black (1934) [18]. Cation exchange capacity was determined by leaching the soil with neutral normal ammonium acetate as described by Jackson (1973) [8]. Mechanical Composition (Particle size analysis) was determined by international pipette method (Day 1965) [5]

Classification of Soils

After thoroughly studying the morphological and physico-chemical properties of the soil, they were classified up to subgroup level according to Soil Survey Staff (1999) [13].

Results and Discussion

Morphological Characteristics of Soils

Depth of Soil

Depth of soils at different sites varied from 20 cm to more than 150 cm (Table:2 and Figure:2). Soils of Nardaha (P3), Madpal (P7) and Kachnar (P8) were shallow (20cm to 38 cm) with less developed horizons. Phunderdihari (P1), Banrasi (P4) and Chokar (P9) soils were moderately deep (52 cm to 68 cm) whereas the soils of Rajpuri (P2), Darba (P5) and Jora (P6) were deep (> 150 cm) having well developed horizons. The variations in depth were related to their position on landscape (Biswas and Gawande, 1962) [2]. Pedons P3, P7 and P8 were on the upper part of landscape (moderately sloping position) whereas P4, P5 and P6 were on nearly levelled topographic position (gently to very gently sloping position). On nearly levelled topographic position, almost the entire water received as rainfall percolates through the soil. Under such conditions, soils develop normal solum with distinct horizons. Therefore, deep profiles were observed in P4 P5 and P6 pedons.

Soil Colour

Colours of the soils (Table: 2) varied from light red (2.5 YR 6/6) in P3 to light olive brown (2.5 Y 5/4) in P6. The entire soils showed darker colour in surface horizon (lower chromas) and lighter colour in subsurface horizons (higher

chromas) except for Jora soils where an inverse trend was observed, lower horizons being darker in colour. Thus, variation in colour seem to depend upon nature and type of parent material (Sujata *et al.* 1999) [15], chemical and mineralogical composition of soil (Swarnam *et al.* 2004) [16], degree of oxidation, reduction and hydration of iron oxides (Singh *et al.* 2000) [12] and the content of organic matter and complexation of humus with mineral matter.

Soil texture

Soil texture varied from sandy loam through clay loam, sandy clay loam and sandy clay to clayey in different pedons (Table: 2). Soils of Nardaha (P3), Madpal (P7) and Kachnar (P8) were coarse textured while the soils of Rajpuri (P2), Darba (P5) and Jora (P6) were fine textured. In pedons Phunderdihari (P1), Rajpuri (P2) and Banrasi (P4) fineness is increased with depth whereas the texture was constant in all the horizons of other pedons. Texture is an intrinsic property of soil which depends upon the different parent materials and the extent of weathering resulting in soils Soil structure in different pedons did not vary considerably. Moderate, medium and subangular blocky structure (2, m, sbk) was common in all the pedons and almost all the horizons of the profiles. Weak, fine and subangular blocky structure (1, f, sbk) was observed in Nardaha (P3), Madpal (P7) and Kachnar (P8) soils in all the horizons. Soil structure is influenced by organic matter (Singh and Agrawal 2005) [11] and clay content in these pedons (Mini *et al.* 2007) [9].

Soil structure

The soil structure in different pedons did not vary considerably (Table: 2). Moderate, medium and sub angular blocky structure (2, m, sbk) were found common in all the pedons and almost all the horizons of the profiles. Strong, medium and angular blocky (3, m, abk) type of structure observed in sub-surface horizon of P6 may be attributed to higher clay content and low organic matter content (Singh and Agrawal 2005) [11]. Weak, fine and sub angular blocky structure (1, f, sbk) observed in P3, P7 and P8 may be due to comparatively lower organic matter and clay content in these pedons (Mini *et al.* 2007) [9].

Soil Consistency

Wet consistency of the soils (Table: 2) varied from slightly sticky and non-plastic (ss, po) to very sticky and very plastic (vs, vp). Consistence of the Nardaha (P3), Madpal (P7) and Kachnar (P8) soils were found to be slightly-sticky, non-plastc (ss, po) in all the horizons of the profile, whereas very sticky and very plastic consistence (vs, vp) was observed in the entire profile of Jora (P6) soil. Consistence of deep soils in lower horizons was towards very sticky and very plastic. Wet consistence of the soil may vary from sticky to very sticky and plastic to very plastic depending upon the clay content in different horizons of the profile (Sujata *et al.* 1999) [15].

Physico-chemical Characteristics of Soils

Particle Size Distribution

All the pedons showed the dominance of sand fraction (54.6 to 75.3 percent) except Rajpuri (P2), Darba (P5) and Jora (P6) soils where higher clay contents were observed (Table: 3). Clay contents were increased in different horizons with depth in all the pedons except Jora (P6) soil where a variable clay contents were observed in different horizons. As such, percentage of clay were found more in P2, P5 and P6 due to their lower topographic position which favoured accumulation and retention of bases promoting formation of fine minerals (Gupta *et al.*1999) [7]. Decrease in sand fraction along with depth indicates weathering of this fraction to finer particles as evidenced by increase in clay content with concomitant decrease in sand fraction (Patil and Dasog 1999) [10].

Soil Reaction (pH)

There was wide variation in soil pH among different pedons and in different horizons of the profile (Table: 3). Soil pH in surface horizons of the pedons ranged from 5.45 in Phunderdihari (P1) soil to 7.54 in Jora (P6) soil. Soil pH values indicated that all the soils were acidic in reaction except for the soils of Darba (P5), Banrasi (P4) and Jora (P6) which were in the normal range. The lower pH values of P3, P7 and P8 might be due to their higher topographic position (moderately sloping). The acidity of P1, P2 and P3 may be due to acidic parent materials as these pedons were on gently sloping landscape. Comparatively higher pH in P5 and P6 may be due to accumulation of bases removed from uplands. In all the pedons, the pH values increased with depth in different horizon which may be attributed to decrease in organic matter content (Challa *et al.* 2000) [3] and leaching of bases to underlying horizons (Swarnam *et al.* 2004) [16].

Electrical conductivity

Electrical conductivity of different soils in surface horizons ranged from 0.07 dS m^{-1} in Madpal (P7) soil to 0.23 dS m^{-1} in Jora (P6) soil (Table: 3). All the soils were in the normal range with respect to salt concentration. Concentration of salts in different horizons increased with depth in all the horizons except Jora (P6) soil which might be due to translocation of salts from upper layers and their accumulation in lower horizons (Garg *et al.* 2000) [6]. Irregular distribution of soluble salts in pedon 6 (P6) may be attributed to churning of soil by swelling and shrinking clays present in this pedon.

Organic carbon

Organic carbon contents (Table: 3) in surface horizons of soils varied from 2.9 g kg^{-1} in Madpal (P7) to 5.5 g kg^{-1} in Chokar (P9) soil. Organic carbon contents of all the soils were in the lower category except Chokar (P9) and Jora (P6) soils where the contents were in the lower margin of medium category. All the pedons showed a general trend of decreasing organic carbon content in the horizons with increasing depth. Low organic carbon content is primarily related to low leaf fall and lesser accumulation of crop residues (Gupta *et al.* 1999) [7]. Moreover, under tropical climatic conditions, oxidation loss of organic matter results in low organic carbon in the soil.

Cation Exchange Capacity (CEC)

CEC of surface horizons of different soils varied from 8.7 to 41.6 cmol (p+) kg^{-1} soil (Table: 3). The maximum CEC (41.6 cmol(p+)kg^{-1} soil) was observed in Jora (P6) soil and least CEC (8.7cmol(p+)kg^{-1} soil) in Phunderdihari (P1) soil. All the pedons showed an increase in CEC with increase in depth in different horizons which may be attributed to higher clay content in the lower layers (Chaudhary *et al.* 2006) [4].

Classification of Soils

Based on morphological and physico-chemical characteristics, presence or absence of diagnostic surface and subsurface horizons, temperature and moisture regimes and other specific characters, the soils were classified up to subgroup level. Nardaha (P3), Madpal (P7) and Kachnar (P8) soils were

classified as Lithic *Ustorthents*. Phunderdihari (P1), Banrasi (P4) and Chokar (P9) soils were placed in Typic *Hapluestepts* subgroup. Rajpuri (P2) and Darba (P5) soils were keyed out in Typic *Haplustalfs* subgroup. Jora (P6) soil was classified as Typic *Hapluesterts* at subgroup level.

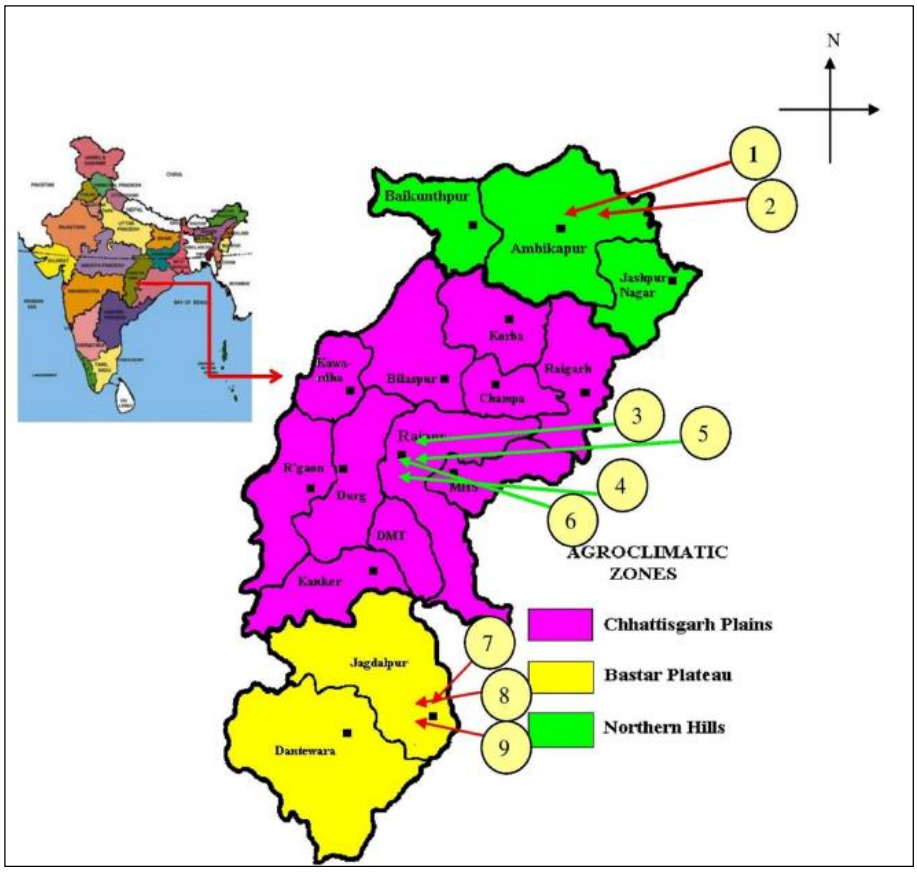

Fig 1: Location Map of the Study Sites

Sites	Village	Tehsil	District
1	Phunderdihari	Ambikapur	Sarguja
2	Rajpuri	Ambikapur	Sarguja
3	Nardaha	Raipur	Raipur
4	Banrasi	Raipur	Raipur
5	Darba	Raipur	Raipur
6	Jora	Raipur	Raipur
7	Madpal	Jagdalpur	Bastar
8	Kachnar	Jagdalpur	Bastar
9	Chokar	Jagdalpur	Bastar

Table 1: Detail of Study Sites

	Pedon - 1	Pedon - 2	Pedon - 3	Pedon - 4	Pedon - 5	Pedon - 6	Pedon - 7	Pedon - 8	Pedon - 9
Location	Village- Phunderdihari Tehsil- Ambikapur District-Sarguja	Village- Rajpuri Tehsil- Ambikapur District- Sarguja	Village- Nardaha Tehsil- Raipur District-Raipur	Village- Banrasi Tehsil- Raipur District- Raipur	Village- Darba Tehsil- Raipur District- Raipur	Village- Jora Tehsil- Raipur District- Raipur	Village- Madpal Tehsil- Jagdalpur District-Bastar	Village- Kachnar Tehsil- Jagdalpur District-Bastar	Village- Chokar Tehsil- Jagdalpur District-Bastar
Co-ordinates	23º 09' N lat. 83º10' E long.	23º 09' N lat. 83º14' E long.	21º 18' N lat. 81º 45' E long.	21º 10' N lat. 81º 43' E long.	21º 15' N lat. 81º 48' E long.	21º 36' N lat. 81º 38' E long.	19º 05' N lat. 82º 07' E long.	19º 10' N lat. 82º 00' E long.	19º 06' N lat. 81º 56' E long.
Physiograph-ic Position	Eastern Baghelkhand plateau	Eastern Baghelkhand plateau	Eastern plateau, Mahanadi Basin	Eastern plateau, Mahanadi Basin	Eastern plateau, Mahanadi Basin	Eastern plateau, Mahanadi Basin	Eastern Dandkaranya plateau	Eastern Dandkaranya plateau	Eastern Dandkaranya plateau
Rainfall (mm)	1200 - 1600	1200 - 1600	1200 - 1400	1200 - 1400	1200 - 1400	1200 - 1400	1200 - 1500	1200 - 1500	1200 - 1500
Elevation (m above MSL)	593	609	285	303	297	271	570	562	546
Slope	3-8% (Gently sloping)	3-8% (Gently sloping)	8-15% (Moderately Sloping)	3-8% (Gently sloping)	3-8% (Gently sloping)	1-3% (Very gently sloping)	8-15% (Moderately Sloping)	8-15% (Moderately Sloping)	3-8% (Gently sloping)

Table 2. Morphological Characteristics of Soils

Depth (cm)	Horizon	Colour (Moist)	Texture	Structure	Consistency (Wet)
		Pedon-1	**(Phunderdihari)**		
0-18	Ap	10 YR 6/4	sl	1,m, sbk	ss,sp
18-45	Bw1	10 YR 6/6	scl	2,m, sbk	s, p
45-68	Bw2	10 YR 6/4	scl	2,m, sbk	s, p
68 - 80+	Cr	Weathered Parent Material			
		Pedon-2	**(Rajpuri)**		
0-18	Ap	10 YR 5/4	cl	1,m, sbk	s, p
18-43	Bt1	10 YR 5/6	cl	2,m, sbk	s, p
43-62	Bt2	10 YR 5/6	cl	2,m, sbk	s, p
62-108	Bt3	10 YR 5/6	sc	2,m, sbk	vs,vp
108-150+	Bt4	10 YR 5/6	sc	2,m, sbk	vs,vp
		Pedon-3	**(Nardaha)**		
0-12	Ap	2.5 YR 6/4	sl	1,f, sbk	ss,po
12-38	AC	2.5 YR 6/6	sl	1,f, sbk	ss,po
38+	R	Hard Rock			
		Pedon-4	**(Banrasi)**		
0-12	Ap	10 YR 5/4	sl	1,m, sbk	ss,sp
12-35	Bw1	10 YR 5/6	sl	2,m, sbk	ss,sp
35-52	Bw2	10 YR 6/4	scl	2,m, sbk	ss,sp
52- 80+	Cr	Weathered Parent Material			
		Pedon-5	**(Darba)**		
0-17	Ap	2.5 Y 6/4	scl	2,m, sbk	s, p
17-55	Bt1	2.5 Y 6/4	scl	2,m, sbk	s, p
55-94	Bt2	2.5 Y 6/4	scl	2,m, sbk	s, vp
94- 150+	Bt3	2.5 Y 6/4	scl	2,m, sbk	s, vp
		Pedon-6	**(Jora)**		
0-19	Ap	2.5 Y 5/6	c	2,m, sbk	vs, vp
19-57	Bw	2.5 Y 5/4	c	3,m, sbk	vs, vp
57-89	Bss1	2.5 Y 5/4	c	3,m, sbk	vs, vp
89-118	Bss2	2.5 Y 5/4	c	3,m, sbk	vs, vp
118-150+	Bss3	2.5 Y 5/4	c	3,c, abk	vs, vp
		Pedon-7	**(Madpal)**		
0-10	Ap	5 YR 6/4	sl	1,f, sbk	ss,po
10- 20	AC	5 YR 5/6	sl	1,f, sbk	ss,po
20+	R	Hard Rock			
		Pedon-8	**(Kachnar)**		
0-11	Ap	5 YR 5/4	sl	1,f, sbk	ss,po
11-31	AC	5 YR 6/4	sl	1,f, sbk	ss,po
31+	R	Hard Rock			
		Pedon-9	**(Chokar)**		
0-14	Ap	5 YR 4/3	sl	1,m, sbk	ss,sp
14- 41	Bw1	5 YR 4/4	sl	2,m, sbk	ss,sp
41-62	Bw2	5 YR 5/4	sl	2,m, sbk	ss,sp
62 - 80+	Cr	Weathered Parent Material			

sl - sandy loam, scl – sandy clay loam, cl- clay loam, sc- sandy clay, 1- weak,
2- moderate, 3- strong, f- fine, m- medium, c- coarse, sbk- subangular blocky,
abk- angular blocky, ss- slightly sticky, sp- slightly plastic, s- sticky, p- plastic, vs- very sticky, vp- very plastic, po- non plastic,

Table 3: Physico-chemical Characteristics of Soils

Depth (cm)	Horizon	Particle -size distribution (%)			pH	EC (dS m^{-1})	Organic carbon (gkg^{-1})	CEC cmol(p+) kg^{-1}
		Sand	**Silt**	**Clay**				
			Pedon-1			**(Phunderdihari)**		
0-18	Ap	62.2	9.1	28.7	5.45	0.17	3.8	8.7
18-45	Bw1	59.5	10	30.5	5.48	0.19	3.6	9.1
45-68	Bw2	54.6	11.1	34.3	5.49	0.19	3.5	9.3
68 - 80+	Cr	Weathered Parent Material						
			Pedon-2			**(Rajpuri)**		
0-18	Ap	41.7	29.9	28.4	5.62	0.2	4.2	9.8
18-43	Bt1	42.5	26.3	31.2	5.65	0.2	4	10.4
43-62	Bt2	44.3	21.9	33.8	5.68	0.21	3.8	10.7
62-108	Bt3	46.5	16.1	37.4	5.7	0.21	3.7	11.2
108-150+	Bt4	47.6	13.1	39.3	5.73	0.23	3.7	11.5
			Pedon-3			**(Nardaha)**		
0-12	Ap	75.3	14.3	10.4	5.65	0.11	3.2	12.4
12-38	AC	74.2	13.1	12.7	5.67	0.12	3	13.3

38+	R	Hard Rock						
			Pedon-4			**(Banrasi)**		
0-12	Ap	61.2	22.5	16.3	6.65	0.13	3.9	19.7
12-35	Bw1	63.1	19.3	17.6	6.67	0.13	3.7	21.3
35-52	Bw2	65.2	15.3	19.5	6.67	0.14	3.7	22.4
52- 80+	Cr	Weathered Parent Material						
			Pedon-5			**(Darba)**		
0-17	Ap	46.5	26.1	27.4	7.21	0.13	4.9	31.5
17-55	Bt1	47.3	23.2	29.5	7.29	0.15	4.6	33.1
55-94	Bt2	48.5	21.1	30.4	7.31	0.15	4.3	36.4
94- 150+	Bt3	48.7	17.1	34.2	7.3	0.17	4.1	36.7
			Pedon-6			**(Jora)**		
0-19	Ap	21.4	28.2	50.4	7.54	0.23	5.1	41.6
19-57	Bw	23.4	22.2	54.4	7.54	0.2	5.1	40.6
57-89	Bss1	23.4	20.2	56.4	7.59	0.21	4.9	40.9
89-118	Bss2	33.4	16.2	50.4	7.62	0.22	4.7	41.6
118-150+	Bss3	33.4	18.2	48.4	7.62	0.20	4.6	39.8
			Pedon-7			**(Madpal)**		
0-10	Ap	73.3	16.3	10.4	5.49	0.07	2.9	10.7
10- 20	AC	71.9	17.3	10.8	5.51	0.08	2.7	11.2
20+	R	Hard Rock						
			Pedon-8			**(Kachnar)**		
0-11	Ap	71.2	17.6	11.2	5.63	0.09	3.5	12.3
11-31	AC	67.4	20.2	12.4	5.65	0.09	3.3	12.9
31+	R	Hard Rock						
			Pedon-9			**(Chokar)**		
0-14	Ap	68.4	13.5	18.1	5.82	0.11	5.5	13.6
14- 41	Bw1	68.7	13.2	18.1	5.85	0.12	5.3	15.5
41-62	Bw2	66.3	15.5	18.2	5.85	0.12	5.2	17.7
62 - 80+	Cr	Weathered Parent Material						

Fig 2: Profile picture and depth of different Pedons

Conclusion

From the present study it was concluded that out of nine soils studied, Phunderdihari and Rajpuri soils of Northern hills zone belonged to *Inceptisols* and *Alfisols* respectively. Nardaha, Banrasi, Darba and Jora soils of Chhattisgarh plain belonged to *Entisols*, *Inceptisols*, *Alfisols* and *Vertisols*, respectively. Madpal and Kachnar soils of Bastar plateau belonged to *Entisols* while Chokar soil belonged to

Inceptisols. Nardaha soil of Chhattisgarh plain and Madpal and Kachnar soils of Bastar plateau were shallow with less developed horizons. Phunderdihari soil of Northern hills zone, Banrasi soil of Chhattisgarh plain and Chokar soil of Bastar plateau were moderate in depth while the Rajpuri soil of Northern hills zone and Darba and Jora soils of Chhattisgarh plain were deep having well developed horizons. Shallow soils were coarser while deep soils were finer in texture. Soil colour varied from light red in Nardaha soil of Chhattisgarh plain through reddish brown in soils of Bastar plateau, yellowish brown in soils of Northern hills zone to light olive brown in Jora soil of Chhattisgarh plain. Moderate, medium and subangular blocky structure (2, m, sbk) was common in all the pedons and almost all the horizons of the profiles in different agro-climatic zones. Wet consistence of soils varied from slightly-sticky, non-plastc (ss, po) in Madpal and Kachnar soils of Bastar plateau through slightly sticky, slightly plastic (ss, sp), sticky and plastic (s, p) in Northern hills zone to very sticky and very plastic (vs, vp) in Jora soil of Chhattisgarh plain. All the soils belonging to Northern hills zone and Bastar plateau and Nardaha soil of Chhattisgarh plain were acidic (pH < 6.0) in soil reaction while those of Banrasi, Darba and Jora soils belonging to Chhattisgarh plain were in the normal range. Salt content in these soils were in the safe limit for crops. All the soils of different agro-climatic zones were low in respect of organic carbon content except Chokar soil of Bastar plateau and Jora soil of Chhattisgarh plain which were in the lower margin of medium category. Acidic soils were having low CEC as compared to normal soils.

References

1. Bear FE. Chemistry of soil. New Delhi: Oxford & IBH Publishing Co. Ltd.; c1964. p. 1.
2. Biswas TD, Gawande SP. Studies in genesis of catenary soils on sedimentary formation in Chhattisgarh basin of Madhya Pradesh I - Morphology and Mechanical Composition. J Indian Soc Soil Sci. 1962;10:233-236.
3. Challa O, Bhaskar BP, Anantwar SG, Gaikwad MS. Characterization and classification of some problematic vertisols in semi-arid ecosystem of Maharashtra plateau. J Indian Soc Soil Sci. 2000;48(1):139-145.
4. Chaudhary DR, Ghosh A, Sharma MK, Chikara J. Characterization of some salt-affected soils of Amethi, Uttar Pradesh. Agropedology. 2006;16(2):126-129.
5. Day PR. Particle fractionation and particle size analysis. In: Methods of Soil Analysis; Part 1. Black CA, Evans DD, Ensminger LE, Clark FE, editors. Agronomy No. 9. Madison: American Society of Agronomy; c1965. p. 545-567.
6. Garg VK, Singh PK, Mathur A. Characterization and classification of sodic soils of the Gangetic alluvial plains at Banthra, Lucknow. Agropedology. 2000;10:163-72.
7. Gupta GP, Tembhare BR, Mishra SR. Characterization and classification of soils of granitic terrain in Jabalpur district of Madhya Pradesh. Agropedology. 1999;9:77-81.
8. Jackson ML. Soil chemical analysis. New Delhi: Prentice Hall of India Pvt. Ltd.; c1973.
9. Mini V, Patil PL, Dasog GS. Characterisation and classification of soils of a pilot site in coastal agro-eco system of North Karnataka. Agropedology. 2007;17(1):59-67.
10. Patil PL, Dasog GS. Genesis and classification of ferruginous soils in Western Ghat and coastal regions of north Karnataka. Agropedology. 1999;9:11-15.
11. Singh IS, Agrawal HP. Characterization, genesis and classification of rice soils of Eastern region of Varanasi, Uttar Pradesh. Agropedology. 2005;15(1):29-38.
12. Singh RN, Singh RNP, Diwakar DPS. Characterization of old alluvial soils of Sone basin. J Indian Soc Soil Sci. 2000;48(2):352-357.
13. Soil Survey Staff. Soil taxonomy - A basic system of soil classification for making and interpreting soil surveys. 2nd ed. Agriculture Handbook No. 436. Washington, D.C.: United States Department of Agriculture; c1999.
14. Subba Rao A, Shrivastava S, Patil SK. Nutrient mining in agro-climatic zones of Chhattisgarh. Fertilizer News. 2001;46(4):109-113.
15. Poddar S, Karmakar RM, Barthakur HP. Characterization and classification of some soils of Arunachal Pradesh. Agropedology. 1999;9:88-92.
16. Swarnam TP, Velmurugan A, Rao YS. Characterization and classification of some soils from Shahibi basin in parts of Haryana and Delhi. Agropedology. 2004;14(2):114-122.
17. Tamgadge DB, Gaikwad MS, Anantwar SG, Gajbhiye KS. Influence of landform on pedon development. J Maharashtra Agric Univ. 2003;28(3):318-320.
18. Walkley A, Black IA. An examination of the Degtjareff method for determining soil organic matter and a proposed modification of the chromic acid titration method. Soil Sci. 1934;37:29-38.