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Characterization of some surface soils of Bihar

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Abstract

Surface soil characteristics of Ultisols (two), Vertisols (four) and Entisols (four) in Bihar indicate differentiating features like particle size distribution, free $CaCO_3$, ECe, pH and CEC. Quartz followed by orthoclase feldspar was the dominant light mineral in all the soils whereas heavy minerals varied with soils in their fine sand fractions. Variations in mineralogical make up are mostly associated with nature and composition of parent material and degree of weathering. The CEC of soils and clays in Vertisols was invariably high as compared to Entisols and Ultisols. Kaolinite is the dominant clay mineral in Ultisols whereas smectite in Vertisols, and illite in Entisols.

Additional keywords : Soil order, light and heavy minerals, parent material.

Introduction

Entisols, Vertisols and Ultisols are found in the parts of north and south Bihar and differ markedly in their chemical properties, mineral assemblage and in turn response to agro-managements. In order to sustain the productivity of land, it is imperative to assess the inherent soil characteristics viz. chemical and mineralogical constituents of soils and with this objective, the present investigation was carried out.

Materials and methods

Ten surface soil samples (0-15 cm) from different locations in Bihar varying in geology, altitude and climate were collected, processed and analysed by standard procedures. Total chemical composition of soils and clays (Black 1965), particle size distribution (international pipette method), free $CaCO_3$, organic carbon, pH, EC of saturation extract (Jackson 1967 and Piper 1966) and CEC (Schollenberger and Simon 1945) were determined. The fine sand fraction of soils was separated into light and heavy suites using bromoform (sp. gr. 2.85) and washed with acetone and dried. The slides were prepared using Canada balsam as a mounting medium

and mineral identification was done using Leitz petrographic microscope (Winchell and Winchell 1951).

Table 1. General information of soils

Location	Physiography	Parent material		Soil Association	Soil order
Kanke (Ranchi)	Upland	Granite-gneis	*in situ*	Red-yellow light gray catenary soil	Ultisol
Bardih (Singhbhum)	Upland	Granite-gneiss	*in situ*	Red-yellow ground water laterite soil	Ultisol
Chakardharpur (Singhbhum)	Midland	Shale	*in situ*	Red-yellow chocolate soil	Vertisol
Putida (Singhbhum)	Lowland	Shale	*in situ*	Mixed red-yellow black catenary soil	Vertisol
Mahraul (Rohtas)	Lowland	Alluvium	Sediments deposited by Durgawati, Suara & other rivers from Adhaura hill	Old alluvium gray, grayish yellow heavy textured soils with cracks	Vertisol
Rajpur (Bhagalpur)	Low land	Alluvium	Backwater depositing during rainy season and remains submerged for about 3-4 months	Tal land soil light gray-dark medium to heavy textured soil	Vertisol
Madhepura (Madhepura)	Mid land	Alluvium	Deposited by Kosi river	Recent alluvium non-calcareous, non saline	Entisol
Champapur (East Champaran)	Mid land	Alluvium	Deposited by Burhi Gandak river	Young alluvium non-calcareous non saline	Entisol
Shampur (Siwan)	Upland	Alluvium	Deposited by Gandak river	Young alluvium calcareous	Entisol
Harpur (Siwan)	Upland	Alluvium	Deposited by Gandak river	Young alluvium saline alkali	Entisol

Results and discussion

Soil-site characteristics of the area are shown in table 1. Ultisols are derived from granite-gneiss whereas Vertisols (Chakardharpur and Putida) from shale. Other Vertisols and Entisols are derived from alluvium. The Vertisols of Mahraul are formed from the sediment deposition through Durgawati, Suara and rivers of Adhaura hill in Rohtas district. The *Tal* land soils (Tiwary and Mishra 1990) are not essentially the true Vertisols (Mishra and Mall 1996). Based on genetic factors, these soils are locally grouped earlier in different classes by Jha (1972).

The physical and chemical properties of surface soils (Table 2) indicate that the Ultisols (Bardih and Kanke) are sandy loam and do not contain free $CaCO_3$. They are slightly acidic (pH 5.8–5.9), low in organic carbon (0.38–0.47%), low in electrical conductivity (0.15-0.19 dS m^{-1}) and high in SiO_2 content (70.4–70.5%). Vertisols (Chakardharpur, Putida, Mahraul and Rajpur) are clayey and contain free $CaCO_3$ (traces to 2.5 per cent), and are neutral to slightly alkaline in reaction (pH 6.8–7.7), low to high in organic carbon content (0.29–0.88%) and high in CEC (29–35 cmol(p+) kg^{-1}). The SiO_2 content of Vertisols was lower than the Ultisols. The ECe was fairly high ranging from 0.58 to 3.55 dS m^{-1}. The Entisols (Madhepura, Champapur, Shampur and Harpur) are light textured (sandy loam to loam). No free $CaCO_3$ are observed in the soils of Madhepur and Champapur. The soils of Madhepura are neutral whereas Champapur soils are slightly alkaline. Shampur soils are mildly calcareous (5.7% free $CaCO_3$) whereas Harpur soils are strongly calcareous (33.8% free $CaCO_3$). Shampur soil being calcareous showed pH of 8.1 whereas Harpur soil indicated comparatively high pH (8.8) and high ECe (34.96 dS m^{-1}). The variation of organic carbon content in Entisols are high (0.35–0.79%). The CEC of Entisols also varied (3.9 and 10.1 cmol (p+) kg^{-1}) and was affected from variation in quality as well as quantity of clays.

The primary mineral suites of these soils are given in table 3. The quartz and orthoclase feldspar are the dominant light minerals in these soils. Entisols (Shampur and Harpur) contained calcite, whereas Vertisols contained plagioclase feldspar. Mica as muscovite and microcline minerals are also present in these soils. Heavy mineral suites are different in different soils and are characteristics to the genesis of these soils.

Table 2. Physical and chemical properties of surface soils

Place	Particle size distribution Sand	Silt	Clay	Texture*	$CaCO_3$ %	pH	ECe dS m^{-1}	O.C. (%)	CEC cmol (p+) kg^{-1}	SiO_2	R_2O_3	CaO	MgO	K_2O
	---------- (%) ----------									---------- (%) ----------				
Kanke	55,6	19,5	24.6	sl	--	5.8	0.19	0.38	7.5	70.5	21.3	0.9	0.5	0.6
Bardih	56.0	19.1	24.9	sl	--	5.9	0.15	0.47	8.8	70.4	19.3	1.5	0.5	0.8
Chakardharpur	17.9	39.8	42.3	c	Tr	6.8	0.58	0.29	29.9	64.0	21.8	1.2	0.5	1.0
Putida	29.5	29.2	41.3	c	2.3	7.6	3.55	0.88	34.7	55.3	27.0	3.2	1.6	0.5
Mahrual	34.1	24.9	41.9	c	Tr	7.5	1.34	0.50	33.0	64.6	18.0	1.6	1.4	1.2
Rajpur	10.2	40.4	49.8	c	2.5	7.7	0.79	0.47	29.0	50.7	37.0	2.3	1.9	2.8
Madhepura	29.7	50.5	19.7	l	--	6.9	0.86	0.79	7.9	60.5	26.0	1.2	1.0	7.1
Champapur	64.1	18.8	17.1	sl	--	7.4	1.17	0.50	6.4	80.0	14.5	1.0	0.6	0.5
Shampur	50.5	30.1	19.4	l	5.7	8.1	1.23	0.38	10.1	65.3	15.5	4.0	1.0	1.4
Harpur	65.1	21.9	13.0	l	33.8	8.8	34.96	0.35	3.9	46.0	11.3	17.2	2.3	1.2

* sl = sandy loam; l = loam and c = clay

Table 3. Primary minerals in fine sand fraction of soils

Place	Light minerals (sp. gr. <2.85)	Heavy minerals (sp. gr. >2.85)
Kanke	Quartz, Orthoclase, Muscovite, Sericite	Zoisite, Tourmaline, Biotite, Apatite, Opaque minerals
Bardih	Quartz, Orthoclase, Microcline, Labroderite	Epidote, Tourmaline, Zircon, Augite, Chlorite, Apatite, Opaque minerals
Chakardharpur	Quartz, Orthoclase, Muscovite, Sericite	Kyanite, Hornblende, Augite, Apatite, Opaque minerals
Putida	Quartz, Orthoclase, Plagioclase, Muscovite	Epidote, Hornblende, Augite, Chlorite Biotite, Apatite, Opaque minerals
Mahrual	Quartz, Orthoclase, Plagioclase, Muscovite	Epidote, Garnet, Tourmaline, Hornblende, Augite, Biotite, Opaque minerals
Rajpur	Quartz, Orthoclase, Plagioclase, Muscovite,	Sericite Zircon, Tourmaline, Augite, Garnet, Biotite, Opaque minerals
Madhepura	Quartz, Orthoclase, Microcline, Muscovite, Sericite	Biotite, Augite, Epidote, Enstatite, Staurolite, Nepheline
Champapur	Quartz, Orthoclase, Microcline, Plagioclase	Kyanite, Epidote, Tourmaline, Hornblende, Augite, Opaque minerals
Shampur	Quartz, Orthoclase, Microcline, Muscovite, Calcite	Epidote, Hornblende, Chlorite, Opaque minerals
Harpur	Quartz, Orthoclase, Plagioclase, Muscovite, Calcite	Epidote, Hornblende, Chlorite, Biotite, Opaque minerals

The chemical composition of clays, their CEC, and molar ratios (Table 4) suggest that the clays of Ultisols are kaolinitic and illitic. The Vertisols indicated the dominance of smectite and showed maximum values of CEC and Entisols showed dominance of illite. Tiwary *et al.* (1968) observed similar type of clay mineral in soils developed on shale in Singhbhum district of Bihar. Mishra and Mall (1996) reported the dominance of illite in the alluvial soils.

Table 4. Chemical composition of soil clays (Percentage on oven dry basis)

Place	SiO_2	R_2O_3	Al_2O_3	Fe_2O_3	CaO	MgO	K_2O	SiO_2/ R_2O_3	SiO_2/ Al_2O_3	CEC (cmol (p+) kg^{-1})
Kanke	40.0	42.0	30.5	11.5	1.1	0.1	1.2	1.8	2.2	29
Bardih	41.5	44.0	31.1	12.9	1.4	0.1	1.4	1.8	2.3	35
Chakardharpur	48.7	38.0	28.3	9.7	0.8	1.4	1.1	2.4	2.9	58
Putida	47.5	35.5	26.9	8.6	1.1	3.8	0.6	2.5	3.0	86
Mahrual	41.5	32.0	21.8	10.2	0.4	3.3	2.0	2.5	3.2	82
Rajpur	47.5	36.0	24.2	11.8	0.4	2.3	2.4	2.6	3.3	60
Madhepura	42.5	40.0	26.6	13.4	1.4	1.0	2.4	2.1	2.7	38
Champapur	44.0	38.0	26.2	11.8	0.9	1.4	2.8	2.2	2.9	38
Shampur	46.0	37.5	30.0	7.5	1.3	1.3	2.4	2.3	2.6	52
Harpur	41.0	31.1	24.7	6.4	0.9	2.3	2.6	2.4	2.8	54

The basic information about Entisols, Vertisols and Ultisols widely occurring in different parts of Bihar may be used to manage these soils.

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