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MINERALOGICAL AND CHEMICAL CHARACTERISTICS OF NIMONE SERIES OF AHMA DNAGAR DISTRICT MAHARASHTRA

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ABSTRACT

The mineralogical and chemical properties of a profile in Nimone series of Ahmadnagar district in Maharashtra was studied. Soil reaction was strongly alkaline (pH 8.4 to 8.5) and electrical conductivity ranged from 0.10 to 0.53 dSm^{-1}. The organic carbon content was low to moderate and it decreased with depth whereas calcium carbonate increased with depth. Among the exchangeable cations, calcium is the dominant one followed by magnesium, sodium and potassium with increase in ESP with depth. The X-ray diffraction analysis showed that the fine clay fractions are mostly composed of smectite with small amounts of vermiculite, chlorite, and feldspar whereas mica and kaoline content in fine clays are in traces.

KEYWORDS*:* Chemical, Mineralogical, Smectite

INTRODUCTION

Vertisols and their intergrades are fine-textured soils with clay content varying from 30 to 70 percent which sometime may be as high as 88 percent (Dudal, 1965, de Vos and Virgo, 1969, Murthy et al., 1982, Landey et al., 1982, Kaswala and Deshpande, 1986). Vertisols are neutral to alkaline in reaction (pH 7.1 to 9.3) because they are mostly derived from calcareous or base-rich parent materials. Black soils of the Deccan region have been reported as poor to rich in organic carbon (0.3 to 1.36 per cent) (Murthy et al., 1982, Pal and Deshpande, 1987). Many researchers reported < 1 per cent organic matter in black soils of Maharashtra and India (Nimkar, 1990., Balpande et al. 1996). Calcium is the most dominant cation accounting for 52 to 85 per cent of the total exchange complex, magnesium usually with depth in Vertisols of Maharashtra. However, in some soils Mg^{2+} ions often dominate the exchange site where ESP values are > 5. Vertisols have high cation exchange capacity, although it depends on the actual content and type of clay. Therefore, knowledge of characteristics of soil clays may help us to develop a comprehensive understanding of the various properties of shrink-swell soils and also nutrient management of these soils.

MATERIALS AND METHODS

Site Characteristics

The study area is Nimone village in Ahmadnagar district which lies between Latitude 19°22’01”N, Longitude 74°39’25” E. Soil is classified as Very fine, smectitic (cal), isohyperthermic, Aridic Haplusterts. Physiographic position was upper Maharashtra Deccan Plateau. Topography and slope was very gently sloping to slightly undulating, 1-3% (50-150 m) and has moderately well drained condition.

The climax vegetation consists of Acacia, neem land use was under Cotton-Wheat/Chickpea system, sugarcane.

Sample Preparation and Analytical Methods

Profiles were dug at selected sites and detailed morphological examination was carried out as per procedures laid down in USDA Soil Survey Manual (Soil Survey Division Staff, 1995). Soil samples were collected horizon-wise. Mechanical analysis was carried out using the pipette method. Organic C was determined by the Walkley-Black method. Ca and Mg in the extracts were determined by atomic absorption spectrophotometry while Na and K were estimated by flame emission spectrophotometry. The mineralogy of the clay fractions of the soils, obtained during mechanical analysis, was investigated by means of X-ray diffraction.

RESULTS AND DISCUSSIONS

Soil Minerological Properties

The fine clay fractions are mostly composed of smectite with small amounts of vermiculite, chlorite, and feldspar. Mica and kaoline content in fine clays are in traces (Table 1). On glycolation, the 1.4 nm peak expanded to about 1.79 nm (P1) and 1.76nm (P2) indicating the presence of smectites. On K-saturation at 25°C the smectite peak shifted from 1.4 to 1.2 nm, which is characteristic of smectite (Pal and Deshpande, 1987). The shifting of the 1.0 nm peak of K-saturated and heated (300°C) and its disappearance at 550°C and HCl treatments indicate the absence of kaolin. The smectite was little chloritzed as evidenced by the broadening towards the low angle side of 1.0 nm peak in K-saturated sample after subsequent heating to 550°C. Such chloritization is common in black soil (Pal and Deshpande, 1987a; Pal and Durge, 1989; Balpande, 1993; Kadu, 1997).

Chemical Properties of Soil

Soil Reaction (Ph) and EC

The pH of the soils (1:2 soil water suspension) ranged between 8.4 to 8.5 i.e. strongly alkaline (Table 2), which increased with depth of the pedon. The values of electrical conductivity ranged from 0.10 to 0.53 dSm^{-1} at 25^oC (Table 2), which shows irregular trend. The variation of EC with depth might be due to leaching of salts from surface to down below through percolating water followed by high evaporative demand resulting in the accumulation of salts in the subsurface horizon (Kharche, 1990). Therefore the soluble salts may not pose any problems to the crops.

Organic Carbon

The organic carbon content in these soils ranged from 0.36 to 0.88 per cent which is low to moderate and in general decreased with depth (Table 2). Despite the addition of regular foliage and root accumulation as organic matter in soils the organic carbon has not been improved due to high rate of decomposition of semi-arid environment (Velayutham et al., 2000).

Calcium Carbonate Equivalent ($Caco_3$)

Calcium carbonate ranged from 14.1 to 16.3 per cent (Table 2) and increased with depth. Calcareousness in Vertisols is due to the presence of both pedogenic and non-pedogenic $CaCO_3$ (Pal et al., 2009) since both the forms react with HCl, it is difficult to distinguish one from the other.

Exchangeable Cations and Base Saturation of Soils

Among the exchangeable cations, calcium is the dominant one followed by magnesium, sodium and potassium in indicating calcium bearing minerals in parent rocks. Similar results were reported by Maji et al. (2005). Exchangeable calcium decreased with depth, exchangeable magnesium increased with depth (Table 2). The base saturation of these soils varied from 109 to 153 per cent.

ESP

The ESP value is less than 5 for surface and sub-surface soil in pedon and it was increased later with depth. This indicates that high amount of sodium in soils cause poor physical properties and in impairing hydraulic properties of cracking clay soils (Balpande et al., 1996).

CONCLUSIONS

In views of the above, it can be stated that soil was alkaline in nature. Although the soils generally contained high amounts of extractable bases, and had high CEC, the amount of organic carbon in the pedon was very low, < 1%. Percentage base saturation and exchangeable sodium percentage increased with depth in pedon due to the presence of large amounts of calcium carbonate nodules and high levels of extractable sodium in the soils. The fine clay fractions are mostly composed of smectite with small amounts of vermiculite, chlorite, and feldspar whereas mica and kaoline content in fine clays are in traces.

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APPENDICES

Table 1: Mineralogical Properties of Soil

Horizon	Depth (cm)	Clay Minerals (%)						
		Smectite	Vermiculite	Chlorite	Kaolin	Mica	Quartz	Feldspar
Nimone Series								
Ap	0-13	86	7	1	Tr	Tr	Tr	Tr
Bw1	13-38	87	8	2	Tr	Tr	Tr	Tr
Bw2	38-55	88	8	1	Tr	Tr	Tr	Tr
Bss1	55-94	87	4	2	Tr	Tr	Tr	Tr
Bss2	94-128	89	3	3	Tr	Tr	Tr	Tr
Bw/Bc	128-150	88	2	3	Tr	Tr	Tr	Tr

*Tr-Traces

Table 2: Chemical Properties of Soils

Horizon	Depth (Cm)	Ph (1:2) H_2O	EC 1:2 Ds M^{-1}	Org. C. (%)	$Caco_3$ (%) Equivalent	Extractable Bases				Sum	CEC	BS (%)	ESP
						Ca^{++}	Mg^{++}	Na^{+}	K^{+}				
						<----------cmol (p^{+}) kg^{-1}---------->							
Ap	0-13	8.4	0.13	0.88	14.1	37.8	15.6	1.1	0.8	55.3	50.6	109	2.2
Bw1	13-38	8.4	0.15	0.68	14.4	36.4	15.6	1.1	0.5	53.6	48.5	110	2.3
Bw2	38-55	8.5	0.10	0.64	15.7	33.3	20.0	2.8	0.4	56.5	48.7	116	5.7
Bss1	55-94	8.5	0.33	0.63	14.5	31.6	20.0	4.2	0.4	56.2	48.7	115	8.6
Bss2	94-128	8.5	0.53	0.51	15.8	31.0	23.1	5.2	0.5	59.8	48.3	124	10.8
Bw/Bc	128-150+	8.5	1.15	0.36	16.3	39.9	20.7	4.7	0.4	65.7	42.8	153	11