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Morphology, physico-chemical properties and classification of some vertisols of Jabalpur

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ABSTRACT

Three Vertisol pedons in Jabalpur district, were morphologically studied, characterized and classified. The soils are very deep, colour ranges from dark brown (10YR3/1) to very dark grey (10YR4/3) in different horizons. The texture of deep soils clay of all pedons throughout the profile. Crack of 2-3 cm wide extends beyond one meter. Slickensides, wedge shaped aggreagates, Fe, Mn and calcrets are observed in all the soils pedons. The soil are imperfectly drained. The soils are calcareous and P^H ranged form neutral to mildy alkaline. The organic carbon content in these soils were low to medium in surface and that too decreased with depth. Effervescence was observed in all the soils pedons in lower horizons. The soils are base rich and high in CEC : clay ratio (0.60 to 0.93) and are classifed as Typic Haplusterts.

Key words: Soil morphology, Physical and chemical characteristics, Taxonomy,

INTRODUCTION

In Madhya Pradesh, Vertisols occupy 16.7 m ha (Tomar *et al.,* 1995) mainly in the districts of Jabalpur, Narsinghpur, Hosangabad, Sagar, Indore, Khandwa, Khargone, Dhar, Dewas, Shajapur, Bhopal etc. The dominant soil constraints are unfavourable tilth, wide and deep shrinkage cracks, slow saturated hydraulic conductivity in sub soil and prone to erosion in the uplands. However, an adequate information on characteristics of these soils is rather limited in Madhya Pradesh and hence present investigation was carried out.

MATERIALS AND METHODS

The study was carried out at Department of Soil Science and Agricultural Chemistry, Jawaharlal Nehru University Jabalpur.

The climate of the area is hot sub-humid (dry) with well expressed summer (March to May), rainy season (June to October) and winter season (November to February). The mean annual rainfall 1406.23 mm of which more than 85 percent is received during monsoon months. Soils moisture regime is Typic ustic with hyperthermic soil temperature regime.

Three pedons were morphologically discribed (Soil Survery Division Staff, 1995). Horizonwise soil samples were collected, dried and processed. The samples were analysed for particle size distribution by Bouyoucos hydrometer method, bulk density by tapping method (Johnson, 1979) and P^H and electrical conductivity in 1:2.5 soil water suspension (Piper, 1966). Calcium carbonate was estimated by rapid titration method (Piper, 1966). Cation exchange capacity and exchangeable cations were determined as described as described by Bower *et al.* (1952) and Black (1965), respectively. Based on morhpological, physical and chemical properties, the soils were classified as per keys to Soil Taxonomy (Soil Survery staff, 1998).

RESULTS AND DISCUSSION

Morphological features of the soils

Salient morphological characteristics of the pedons are presented in Table -1. The colour of the soil in hue 10YR, value ranged form 2 to 4 and chroma 1 to 2 and the low chroma indicates poor drainage of the soils. The dark colour in these soils may be partly due to high content of ilmenite along with other dark coloured ferromagnesion minerals (Sahu *et al.,*1982). Granular to weak fine sub angular blocky structure was noticed in surface horizons of all the pedons, while strong medium angular blocky to strong coarse angular blocky structure in sub soil horizons of pedons 1 and 3. The structure is sub soil horizons of pedon 2 was moderate medium sub angular blocky throughout the profile. Crack of 1 to 3 cm wide gilgai. micro-relief are normal surface features in the area. These soils have intersecting slickensides and shiny pressure faces in sub surface horizon indicating shrink swell properties of the soils. Presence of Fe-Mn cocretions in all the sub surface horizons is attributed to slow to very slow permeability and reduction - oxidation cycle. Few and fine to coarse irregular calcrets are observed in the lower horizons of all the pedons.

Physical and chemical properties

The data on particle size distribution (Table 2) indicate that the soil were clayey throughout the profiles. The clay content was

Table - 1: Morphological characteristics of the soils

Horizon	Depth (cm)	Colour (Moist)	Texture	Structure	Cocretions	Efferve-scence	Others*
Pedon 1		**Very fine, Smectitic, hyperthermic, typic haplusterts**					
Ap	0-12	10YR3/2	c	1fsbk	-	-	
A12	12-30	10YR3/2	c	3mabk	ff, conir, consi	eh	1-3
BSS1	30-60	10YR3/2	c	3mabk	ff, conir, consi	ev	1-2, pf, ss
BSS2	60-100	10YR3/2	c	3mabk	ff, conca, conir, consi	ev	1-2, pf, ss
BSS3	100-129	10YR3/2	c	3mabk	ff, conir, conca	ev	1-2, ss
BSS4	129-159	10YR3/2	c	3mabk	ff, conir, conca	ev	
BC	159-162	10YR3/2	c	3mabk	ff, conir, conca	ev	
Pedon 2							
Ap	0-11	10YR3/1	c	gr			-
A12	11-25	10YR3/1	c	1Fsbk	ff conca	-	
A13	25-65	10YR3/1	c	2msbk	ff conca	-	1-3
BSS1	65-114	10YR3/2	c	2msbk	ff conir, conca, consi	-	1-2, ss
BSS2	114-146	10YR4/3	c	2msbk	ff conca, consi	e	1-2, ss
BC	146-156	10YR3/1	c	2msbk	ff conca	e	
C	156-200	10YR3/1	c	2msbk	ff conca	e	
Pedon 3							
Ap	0-5	10YR3/2	c	1fsbk	ff conir	-	
A12	5-20	10YR3/2	c	3cabk	ff conir, consi	-	2-4, pf
BW	20-38	10YR3/2	c	3cabk	ff conir, consi	-	1-2, ss
BSS1	38-44	10YR3/2	c	3cabk	ff conir, conca	e	1-2, ss
BSS2	44-114	10YR3/2	c	3cabk	ff conir	es	1-2, ss
BC	114-143	10YR3/2	c	3cabk	ff conir, conca	es	

pf = Pressure faces, ss = silcken sides,
The abbreviations are as per Soil Survey Manual (Soil Survey Staff, 1995)

Table - 2: Physical properties of the soils

Horizon	Depth (cm)	Sand (%)	Silt (%)	Clay (%)	B.D. (Mg m^{-3})
Pedon 1 Very fine, Smectitic, hyperthermic, typic haplusterts					
Ap	0-12	14.99	25.71	59.30	1.56
A12	12-30	15.77	25.71	58.52	1.59
BSS1	30-60	14.79	24.78	60.63	1.62
BSS2	60-100	12.08	23.17	60.75	1.66
BSS3	100-129	10.58	24.86	64.56	1.67
BSS4	129-159	9.26	26.67	63.87	1.69
BC	159-162	10.34	23.24	66.42	1.68
Pedon 2 Very fine, smectitic, hyperthermic, typic haplusters					
Ap	0-11	14.98	25.86	59.16	1.43
A12	11-25	14.45	24.63	60.92	1.44
A13	25-65	8.57	25.72	65.71	1.47
BSS1	65-114	8.70	18.34	72.96	1.50
BSS2	114-146	15.23	14.33	70.44	1.49
BC	146-156	13.11	29.51	57.38	1.51
C	156-200	11.05	25.24	63.71	1.52
Pedon 3 Fine, smectitic, hyperthermic, typic haplusters					
Ap	0-5	30.25	20.40	49.35	1.69
A12	5-20	32.65	18.72	48.63	1.70
BW	20-38	31.32	18.42	50.26	1.76
BSS1	38-44	30.87	17.87	51.32	1.78
BSS2	44-114	29.74	16.92	53.34	1.80
BC	114-143	30.81	19.03	50.16	1.82

increased in the sub soils. The bulk density ranged from 1.43 to 1.82 Mg m^{-3}. It was low in surface horizons and increased with depth in all the pedons. The lower bulk density in surface horizon may be due to comparatively higher organic matter content. The P^H of the soil ranged from 7.1 to 7.7. The electrical conductivity values are invariably low ranging form 0.03 to 0.34 DSm^{-1}. Organic carbon content ranged from 0.3 to 6.6g Kg^{-1}, and tended to derease with depth. The content of $CaCO_3$ in these soils increased with depth and it ranged from 5 to 27.5 g Kg^{-1}. Similar trends were reported by Chichmaltpure *et al.,* (1998) in Vertisols of micro-watershed of Wanna catchment near Nagpur. The CEC values of soil (Table 3) varied from 38.65 to 59.34 cmol (p+) $kg^{-1}$and increased with depth showing its direct relationship with clay content (r=0.98). The exchange complex is mostly saturated with Ca^{++} followed by Mg^{++}, Na^{+} and K^{+}. The exchangeable Mg^{++} and Na^{+} increased and Ca^{++} remained almost constant with depth. It is assumed that Na and Mg salts are relatively more soluble than the Ca salts and leached down to lower layers. The soils are highly saturated with bases. Higher ratio of CEC: clay (0.60-0.93) is due to smectitic minerals.

Classification of the soils

Based on morphological and physico-chemical properties the soils of the study area have been classified as per the criteria given in the keys to soil Taxonomy (Soil Survey Staff, 1998). The presence of a layer more than 25 cm thick associated with slickensides close enough to intersect in sub horizons, more than 30 percent clay in the fine earth fraction and 1-3cm wide cracks upto 1 meter qualify for Vertisols (P_1 P_2 and P_3) and Typic Haplusterts as sub group level.

Table - 3: Chemical properties of pedons

Horizon	Depth (cm)	pH	EC (dSm^{-1})	$CaCO_3$ ($g\ kg^{-1}$)	0.C ($g\ kg^{-1}$)	CEC cmol (P+) kg^{-1}	Exchangeable cations (cmol (P+) kg^{-1} Ca^{++}	Mg^{++}	NA^{+}	K^{+}	CEC/clay ratio
Pedon 1	**Very fine, smectitic, hyperthermic, typic haplusters**										
Ap	0-12	7.2	0.31	7.8	3.5	48.21	33.79	12.25	0.92	0.92	0.81
A12	12-30	7.3	0.30	12.4	2.9	50.44	34.40	14.13	0.65	0.65	0.86
BSS1	30-60	7.3	0.33	15.13	2.3	50.05	34.27	15.78	0.61	0.61	0.82
BSS2	60-100	7.3	0.31	18.71	2.5	53.84	35.22	16.37	0.65	0.65	0.88
BSS3	100-129	7.4	0.30	20.0	2.1	48.23	34.32	12.17	0.62	0.62	0.74
BSS4	129-159	7.6	0.31	22.7	1.3	38.65	26.33	10.62	0.62	0.62	0.60
BC	159-162	7.6	0.28	21.30	0.3	45.39	30.34	13.18	0.68	0.68	0.8
Pedon 2	**Very fine, smectitic, hyperthermic, typic haplusters**										
Ap	0-11	7.1	0.32	10.0	6.6	47.05	34.69	10.72	0.80	0.89	0.84
A12	11-25	7.1	0.30	14.34	3.3	48.71	35.04	11.56	1.38	0.73	0.79
A13	25-65	7.2	0.31	17.21	2.5	50.16	34.25	13.47	1.67	0.77	0.72
BSS1	65-114	7.3	0.29	17.58	1.7	59.34	36.81	18.60	1.90	0.70	0.82
BSS2	114-146	7.3	0.34	16.91	2.1	54.50	37.07	15.89	1.88	0.66	0.74
BC	146-156	7.4	0.31	17.41	1.5	49.80	36.33	13.36	1.12	0.68	0.72
C	156-200	7.5	0.30	16.36	1.4	48.76	30.54	13.58	0.82	0.71	0.77
Pedon 3	**Fine, smectitic, hyperthermic, typic haplusters**										
Ap	0-5	7.3	0.03	6	6.6	44.37	28.91	10.96	0.67	0.57	0.89
A12	5-20	7.4	0.05	10	6.4	44.50	29.57	11.04	0.71	0.62	0.91
BW	20-38	7.5	0.04	12	6.2	45.62	29.89	12.20	0.75	0.66	0.90
BSS1	38-44	7.6	0.04	14	5.8	46.32	30.30	13.40	0.79	0.71	0.90
BSS2	44-114	7.6	0.05	15	4.5	47.28	29.94	12.84	0.77	0.69	0.89
BC	114-143	7.7	0.08	20	4.1	46.16	28.81	13.89	0.76	0.68	0.93

REFERENCES

1. Black, C.A. Methods of Soil Analysis. Part I & II. *Agronomy Series No.0 Amer* (1965).
2. Bouyoucos, G.J. The hydrometer as a new method for mechanical analysis of soils. *Soil Science,* **23:** 234-353 (1927).
3. Bower, C.A. : Reilemeter, R.F. and Fireman, M. Exchangeable cation analysis of saline and alkali soils. *Soil Science,* **73:** 151-261 (1952).
4. Chinchmaltpure, A.R.; Gowrisankar, D., Cchalla, O. and Seghal J. Soil site suit ability of micro-watershed of Wunna catchment near Nagpur. *J. Indian Society of Soil Science,* **46:** 657-661 (1998).
5. Johnson, I.J. *Introductory soil Science* - A study Guide and Laboratory Manual, Macmillan Pub. Co. Inc. USA, 69-71 (1979).
6. Piper, C.S. Soil and Plant Analysis. Hans Publisher Bombay Soc. of Agro. Inc. Madison, Wisconison U.S.A (1966).
7. Sahu, G.C.; Nanda, S.S.K and panda, N. Gensis and mineralogy of some vertisols in Orissa-1, *University of Agriculture and Technology Journal of Research,* **12:** 1-12 (1982).
8. Soil Survey Staff' Keys of soils Taxonomy', Eighth Edition (USDA: Washigton D.C) (1988).
9. Tomar, V.S.,Gupta, G.P. and Kaushal, G.S. Soil resources and agroclimatic zones of Madhya Pradesh, Department of Soil Science and Agricultural Chemistry, JNKVV, Jabalpur. M.P., 132 (1995).