RESEARCH ARTICLE

CHARACTERIZATION AND CLASSIFICATION OF SOILS OF JHALARAPATAN BLOCK, JHALAWAR DISTRICT OF RAJASTHAN

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Received-02.03.2017, Revised-16.03.2017

Abstract: A detailed soil survey of cluster of 10 villages in Jhalarapatan block, Jhalawar district of Rajasthan was carried out at 1: 8000 scales. Five typifying pedons representing undulating and alluvial plain landforms were studied for their morphological and physico-chemical properties. The soils were shallow to very deep, well to moderately well drained, moderately eroded, clay in texture developed over sandstone and basaltic parent materials. Soils of the undulating belong to *Typic Haplustept* while soils of the plain were classified as *Typic Haplustert*. The soils were slightly alkaline to strongly alkaline in reaction pH (7.78-8.76). Electrical conductivity ranged between 0.10-2.65 dSm^{-1}, organic carbon varied from 0.08-0.99 g kg^{-1}, cation exchange capacity ranged from 13.0- 56.5 cmol (p^+) kg^{-1}. Soils were low in available nitrogen (68.0-184.7 kg ha^{-1}), low to medium in phosphorus (3.4-20.2 kg ha^{-1}) and high in available potassium (1092 kg ha^{-1}). Soils were medium to high in available zinc (0.18-3.6 mg kg^{-1}), high in available iron (5.84-26.46 mg kg^{-1}) and copper (0.67-4.32 mg kg^{-1}). Available manganese was low to high (1.24-21.86 mg kg^{-1}).

Keywords: Soil, Survey, Morphology, Land resources

INTRODUCTION

Precise scientific information on characteristics, potentials, limitations and management needs of different soils is indispensable for planned development of land resources to maintain the soil productivity and to meet the demands of the future. Soil resource inventory provides an insight into the potentialities and limitations of soils for the optimum utilization. It also provides adequate information in terms of landform, terrain, vegetation as well as characteristics of soils which can be utilized for land resources management and development (Manchanda *et al.* 2002). Agricultural intensification and massive infrastructure development in recent years without considering the variability of entire production system enhances the risk of soil erosion and fertility depletion (Singh *et al.* 2007). In order to perform good management practices and remedial measures for various soil limitations, a systematic study of the soils is highly essential. Hence, the present investigation was taken up to characterize and classify the soils.

MATERIAL AND METHOD

Geographically, the Jhalarapatan block lies between 76^o10’30’’ E longitude and 24^o 32’10’’ N latitude. The general elevation of the study area also in ranges from 540 m above mean sea level (MSL). The drainage is essentially, subparallel and dendritic in the block. Climate of the block is sub- humid with mean annual rainfall of 833 mm, mean annual temperature of 25^0 C. The relative humidity is 15-20 per cent. The area qualifies ‘*hyperthermic*’ soil temperature regimes. Geology of the study area is dominantly of basaltic rocks, sandstone and shales with a band of limestone. Major part of the block is in the basin of Kalisindh and Ahu rivers. The major crops in the area are wheat, mustard, coriander, garlic, kalongi and gram in *Rabi* season and Jowar, maize cotton and soyabean in *Kharif* season.

The soil survey was carried out in ten villages covering an area of 2704.71 ha using base map at 1:8000 scale. A detailed traverse of the area was made to identify the landforms. Pedon sites were located in transects along the slope from the upper to lower slopes. Five typifying pedons were exposed and studied for morphological characteristics as per Soil Survey Manual (Soil Survey Division Staff, 1999). The horizon-wise soil samples were collected, air dried and passed through 2 mm sieve and analyzed for particle-size distribution following International Pipette method (Richards, 1954), pH and electrical conductivity (EC) in 1:2.5, soil : water suspension (Pipper 1966). Organic carbon was estimated by Walkley and Black (1934) method and calcium carbonate by rapid titration method (Piper 1966). The cation exchange capacity (CEC) and exchangeable cations were determined as described by Jackson (1958). The soils were classified as per Soil Taxonomy (Soil Survey Staff 2003).

RESULT AND DISCUSSION

Five pedons representing Neemoda-A, Neemoda-B, Khanpuriya-A, Khanpuriya-B and Salriya were described here under.

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Soil Morphology and Taxonomy

The data revealed (Table 1) that the soils of Neemoda-A series were deep, well drained, clay loam texture, very dark grayish brown (10YR 3/2) color and classified as Fine, smectitic, calcareous, hyperthermic *Typic Haplustert*. These soils occur on nearly level 1-3 per cent slopes whereas, the soils of Neemoda-B series were moderately deep, well drained, silty clay surface texture and clay sub-surface texture, very dark grayish brown (10YR 3/2) color and classified as Fine, mixed, calcareous, hyperthermic, *Typic Haplustept* which are developed on sandstone and basaltic materials. The soils of Khanpuriya-A were shallow, well drained, silty loam surface texture, dark brown (10YR 3/3) to very dark grayish brown (10YR 3/2) in colour and classified as Fine-silty, mixed, calcareous hyperthermic *Typic Haplustept*, whereas, the soils of Khanpuriya-B series were moderately shallow, well drained, silty clay surface texture followed by silty clay sub-surface texture, dark brown (10YR 3/3) to very dark grayish brown (10YR 3/2) in color and classified as Fine silty-over cleyey, mixed, hyperthermic, *Fluventic Haplustept*. The soils of Salariya series were very deep, well drained, clay texture, dark brown (7.5YR 3/2) in color and classified as Very-fine, smectitic calcareous, hyperthermic *Typic Haplusttept*.

The color of soils under moist condition from pedon I to II was very dark grayish brown (10YR 3/2), whereas, the color of pedon III to IV was dark brown (10YR 3/3) and color of pedon V was dark brown (7.5YR 3/2). This difference in colour may be attributed to the organic matter and high clay content (Diwakar and Singh 1992).

The structure of the soils was sub-angular blocky with variable grades. The relative distribution of cations like Ca^{2+}, fe^{2+} etc. along with organic matter appear to be influencing the development of mostly angular blocky structures (Diwakar and Singh 1992; Diwakar 2005). The consistency of these soils was hard, moderate sticky and moderately plastic, under dry and moist conditions. It might be attributed to the dominance of smectite of clay minerals along with the clayey texture of the soils (Diwakar and Singh 1992).

Physico-chemical properties of soils

The data (Table 2) indicate that the sand content in soils ranged from 2.0 to 59.7 per cent with a mean value of 18.6 per cent. Higher sand content is noticed in soils of Khanpuriya-A and Khanpuriya-B developed on plain landforms. The silt content ranged from 14.9 to 73.2 per cent with a mean value of 41.3 per cent. The silt content in all the pedons have irregular trend with the depth. Clay content ranged from 16.2 to 74.2 per cent with a mean value of 40.1per cent. Higher clay content is noticed in soils of Neemoda-B and Salariya. Higher clay content was found in the sub-surface horizons because of the illuviation of fine fractions from the surface layers.

Soils of Neemoda-A series are slightly alkaline to moderately alkaline pH (7.78 to 8.36), (Table 2) whereas, the soils of Neemoda-B and Khanpuriya-A series are moderately alkaline to strongly alkaline pH (7.90-8.58) and the soils of Khanpuriya-B and Salariya series are strongly alkaline pH (8.02-8.64). The electrical conductivity (EC) ranged from 0.10 to 2.65 dSm^{-1}. Except two soil samples all are under < 1 dSm^{-1}. It indicates that they are non-saline in nature as suggested by Muhr *et al.* (1963) comparatively low content of soluble salts appear to be due to the type of climate (sub-humid) of the area which is fairly sufficient to leach out major part of soluble salts from the soil. The organic carbon (OC) content in these soils is ranged from 0.08 to 0.99 g kg^{-1}. It showed a considerable variation with types and topography of soil. Relatively higher values of organic carbon can be ascribed to annual addition of plant residues and also the application of FYM.

Cation exchange capacity of typifying pedons ranged from 13.0 to 56.5 cmol (p^+) kg^{-1} with an average value of 29.37 cmol (p^+) kg^{-1}. The CEC increased with increase in clay content of the pedons. Higher values of CEC in sub-surface horizon commensurate with amount of clay .The CEC increased with depth in the pedons of Khanpuriya-A and Salariya series due to increase in clay content of lower horizons. The CEC decreased with depth in the pedons Neemoda-A, Neemoda-B and Khanpuriya-B series due to variation in clay and organic matter content (Mishra and Ghosh, 1995). The soils of Neemoda-A, Neemoda-B, Khanpuriya-A and Salariya series are calcareous whereas the soils of Khanpuriya-B are non-calcareous. The exchangeable bases had distinct pattern regarding their sequential dominance. In all the pedons, the order followed was Ca>Mg>Na>K. Similar results were observed by Diwakar and Singh (1994). The Ca^{2+} in soils ranged from 4.34 to 39.4 cmol (p^+) kg^{-1}, with a mean value of 19.83 cmol (p^+) kg^{-1}, Mg^{2+} ranged from 1.2 to 20.2 cmol (p^+) kg^{-1} with a mean value of 11.8 cmol (p^+) kg^{-1}, Na^+ ranged from 0.01 to 1.5 cmol (p^+) kg^{-1}, with a mean value of 0.17 cmol (p^+) kg^{-1} and K^+ ranged from 0.02 to 0.24 cmol (p^+) kg^{-1} with a mean value of 0.08 cmol (p^+) kg^{-1} (Table 3.).

Fertility status

The fertility status of soils revealed (Table 3) that available nitrogen was low (68.0-184.7 kg ha^{-1}), phosphorus was low to medium (3.4-20.2 kg ha^{-1}) and available potassium was high (1092 kg ha^{-1}). Available zinc content ranged from 0.18-3.6 mg kg^{-1} mg kg^{-1}. Considering 0.6 mg kg^{-1} as the critical limit given by Singh *et al.* (2003), Soils were in general medium to high in available zinc. Available copper ranged between 0.67-4.32 mg kg^{-1}. Considering 0.4 mg kg^{-1} as the critical limit given by Singh *et al.* (2003), all the samples were found sufficient to adequate in available copper. Available iron in soils ranged from 5.84-26.46 mg kg^{-1}. Based on the critical limit as suggested by Lindsay and Norvell (1978) is 4.5 mg kg^{-1} for iron the soils were high in available iron. It may be due to the presence of iron bearing minerals in the soil. Available manganese ranged from 1.24-21.86 mg kg^{-1}. Singh *et al*, (2003) suggested 4.0 mg kg^{-1} as critical limit and accordingly the sufficient amount of Mn in soils was due to the presence of Mn containing minerals.

CONCLUSION

From the present study it can be concluded that distinct relationship exists between soil properties and landform units. The soils on different landforms are at varying degree of pedogenic development. Major part of the block is under Kalisindh and Ahu rivers Predominant influence of Kalisindh and Ahu river system was found on the soil formation and landscape which modified the basic soil characters. The major crops in the area are wheat, mustard, coriander, garlic, kalongi and gram in *Rabi* season and Jowar, maize cotton and soya bean in *Kharif* season. Orange is an important crop in the block,which is a major source of income for farmers. The soil resource data generated in the present investigation could be well utilized for general crop planning of the area with site specific management practices. The data generated will provide the characteristics of soils and fertility status in a map of a particular area so that any scientist, researcher, planner and farmer can utilize the data for further planning. However, more study is needed on pedogenic development of these soils.

Table 1. Morphological characteristics of typifying pedons of Jhalarapatan Block.

Horizon	Depth (cm)	Colour (moist)	Texture	Structure	Gravels	Effervescence	Root distribution
Pedon 1 (Neemoda-A): Fine, smectitic, calcareous, hyperthermic Typic Haplustert							
Ap	0-23	10YR 3/2,	cl	massive	5-10	e	fm
Bss1	23-30	10YR 3/2,	c	m2sbk	5-10	e	fm
Bss2	30-50	10YR 3/2,	c	m2sbk	>10	e s	mm
BC	50-73	10YR 3/4,	l	m2sbk	>35	ev	mm
Ck	73-120	Weathered rock	l	-	>50	ev	-
Pedon 2 (Neemoda-B): Fine, mixed, calcareous, hyperthermic, Typic Haplustept							
Ap	0-18	10YR 3/2	sic	m1sbk	15	e	fm
Bw1	18-35	10YR 3/2	c	m2sbk	-	e	cf
Bw2	35-52	10YR 3/2	c	m2sbk	-	e	cf
Bk	52-90	10YR 4/2	cl	m2sbk	60	ev	-
R	90+	10YR 4/2	-	-	-	ev	-
Pedon 3 (Khanpuriya-A) **:** Fine-silty, mixed, calcareous hyperthermic Typic Haplustept							
Ap	0-9	10YR 3/3	sil	m1sbk	-	-	mvf
Bw1	9-26	10YR 3/2	sil	m2sbk	-	-	cvf
Bw2	26-36	10YR 3/2	sil	m2sbk	-	es	cf
Ck	36-50	10YR 5/2	scl	-	-	ev	-
Pedon 4 (Khanpuriya-B) **:** Fine silty-over cleyey, mixed, hyperthermic, Fluventic Haplustept							
Ap	0-9	10YR 3/3	sil	m1sbk	<10	-	vf
Bw1	9-18	10YR 3/2	sil	m1sbk	<10	-	cf
Bw2	18-37	10YR 3/2	c	m1sbk	<10	-	cf
II Ck	37-60	10YR 5/2	scl		>50	e	-
Pedon 5 (Salariya): Very-fine, smectitic calcareous, hyperthermic Typic Haplusttept							
Ap	0-15	7.5YR 3/2	c	massive	-	es	ff
Bss1	15-45	7.5YR 3/2	c	m2sbk	-	e	ff
Bss2	45-70	7.5YR 3/2	c	m2sbk	-	e	-
Bss3	70-100	5YR 3/4	c	m2sbk	-	-	-
Bss4	100-170	2.5YR 3/4	c		-	-	-

Table 2. Physico-chemical properties of typifying pedons of Jhalarapatan block.

Horizons	Depth (cm)	Sand (%)	Silt (%)	Clay (%)	pH	EC (dSm^{-1})	OC (g kg^{-1})	$CaCO_3$ (g kg^{-1})	CEC [cmol (p^+) kg^{-1}]	Exchangeable cations			
										Ca	Mg	Na	K
										cmol (p^+) kg^{-1}			
Pedon 1 (Neemoda-A): Fine, smectitic, calcareous, hyperthermic Typic Haplustert													
Ap	0-23	22.60	40.68	36.72	7.78	0.71	0.99	6.61	29.0	14.68	14.0	0.08	0.24
Bss1	23-30	15.39	37.99	46.62	8.01	0.44	0.35	5.05	32.4	20.05	12.2	0.09	0.06
Bss2	30-50	15.46	35.60	48.94	8.05	0.45	0.31	5.69	34.4	18.82	15.4	0.13	0.05
BC	50-73	38.80	35.32	25.88	8.06	0.49	0.19	12.69	19.2	5.42	13.6	0.15	0.03
Ck	73-120	40.02	43.79	16.19	8.36	0.32	0.16	16.66	13.0	5.16	18.0	0.14	0.02
Pedon 2 (Neemoda-B): Fine, mixed, calcareous, hyperthermic, Typic Haplustept													
Ap	0-18	8.54	48.64	42.82	8.52	0.38	0.84	5.94	31.0	27.72	3.2	0.01	0.07
Bw1	18-35	9.74	39.61	50.65	8.67	0.32	0.52	7.05	36.1	31.04	5.0	0.11	0.06
Bw2	35-52	9.73	39.30	50.95	7.90	0.27	0.52	9.74	36.7	34.3	2.2	0.15	0.05
Bk	52-90	39.32	31.25	29.43	8.76	0.45	0.19	21.66	21.8	18.0	3.0	0.77	0.03
R	90+	-	-	-	-	-	-	-	-	-	-	-	-
Pedon 3 (Khanpuriya-A) **:** Fine silty-mixed, calcareous hyperthermic Typic Haplustept													

Ap	0-9	9.01	73.19	17.8	8.30	0.37	0.42	4.35	14.32	13.0	1.2	0.08	0.04
Bw1	9-26	10.17	72.27	17.56	8.38	0.30	0.39	4.61	14.8	13.0	1.7	0.07	0.03
Bw2	26-36	11.52	64.70	23.78	8.52	0.34	0.40	9.61	17.2	16.0	1.1	0.07	0.03
Ck	36-50	49.27	22.05	28.68	8.58	0.22	0.11	23.32	21.2	12.49	8.6	0.07	0.04
Pedon 4 (Khanpuriya-B) **:** Fine silty-over cleyey, mixed, hyperthermic, Fluventic Haplusttept													
Ap	0-9	7.28	67.82	24.90	8.53	0.11	0.41	3.50	17.8	12.0	5.7	0.06	0.04
Bw1	9-18	8.19	69.05	22.76	8.54	0.10	0.25	3.78	16.25	12.0	4.2	0.03	0.02
Bw2	18-37	13.12	31.64	55.24	8.42	0.11	0.20	4.06	38.4	20.33	18.0	0.05	0.02
II Ck	37-60	59.7	14.9	25.40	8.53	0.16	0.08	5.56	19.2	4.34	14.6	0.04	0.02
Pedon 5 (Salariya): Very fine-smectitic calcareous, hyperthermic Typic Haplustept													
Ap	0-15	14.37	31.75	53.88	8.41	0.25	0.55	4.50	37.3	21.36	12.2	0.03	0.24
Bss1	15-45	13.07	27.43	59.57	8.64	0.23	0.41	4.35	41.4	25.46	15.6	0.13	0.21
Bss2	45-70	9.41	26.36	64.23	8.47	0.37	0.22	4.18	48.5	39.04	9.0	0.23	0.23
Bss3	70-100	2.94	31.44	65.62	8.07	2.08	0.18	3.68	49.8	36.35	12.8	0.44	0.21
Bss4	100-170	2.04	23.76	74.20	8.02	2.65	0.17	2.95	56.5	35.82	19.0	1.5	0.18

Table 3. Range and mean values of physico-chemical properties and nutrients of soils of Jhalarapatan block.

Ranges	Soil properties																	
	Sand	Silt	clay	pH	EC	OC	$CaCO_3$	CEC	Ca	Mg	Na	K	N	P	K	Cu	Zn	Mn	Fe
	(%)	(%)	(%)		(dSm^{-1})	g k^{-1}	g k^{-1}	cmol (p+) kg^{-1}	cmol (p+) kg^{-1}				Kg ha^{-1}			mg kg^{-1}			
Min.	2.0	14.9	16.2	7.78	0.10	0.08	2.95	13.0	4.34	1.2	0.01	0.02	68.0	3.4	98.6	0.66	0.18	1.24	5.84
Max.	59.7	73.2	74.2	8.76	2.65	0.99	23.32	56.5	39.4	20.2	1.50	0.24	184.7	20.2	1092.0	4.32	3.60	21.86	26.46
Mean	18.6	41.3	40.1	8.34	0.50	0.35	7.70	29.37	19.83	11.8	0.17	0.08	129.7	9.1	394.5	2.39	0.57	7.38	11.41

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