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Characterization and classification of soils of Phalasia block of Udaipur district, Rajasthan

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On soil, a vital natural resource, depends the life supporting systems of a country and socio-economic development of its people. More than ever before, a renewed attention is being given to soils due to rapidly declining area for agriculture, declining soil fertility, increasing soil degradation, wrong land use policies and irrational and imbalanced use of inputs (Kanwar 2004). All the above factors call for a paradigm shift in research away from maximum crop production to sustainability of crop production without degradation of soil health. Agricultural intensification and massive infrastructure development in the recent years without considering the variability of entire production system enhances the risk of soil erosion and fertility depletion (Singh *et al.* 2007). The information about the soils of Phalasia block of Udaipur, Rajasthan is scanty and hence the present investigation was carried out.

The study area (24°10' to 24°12' N; 74°18' to 74°19' E), represents semi-arid monsoonic climate. The annual precipitation is 780 mm of which 85 to 90% is received from June to September. The mean annual summer temperature is 32.7°C while the mean annual winter temperature is 18.4° C. Sorghum, maize and pigeonpea are important *kharif* crops and wheat, barley, gram and mustard are the *rabi* crops. Seven pedons, occurring on lanforms having different slopes in Phalasia block of Udaipur district were examined for their morphological characteristics. Horizon-wise soil samples from typical pedons were collected, processed and were analysed for different physical and chemical properties using standard procedures. The soils were classified as per Keys to Soil Taxonomy (Soil Survey Staff 2003).

Soils occurring on nearly level land (P1) had dark yellowish brown to dark brown colour, and that of very gently (P2) and gently sloping land (P3) exhibited dark brown colour through the depth. Soils occurring on moderately gentle slopes (P4, P5 and P6) exhibited dark brown colour through the depth whereas soils on on moderately steep slopes (P7) had dark yellowish brown colour (surface horizon) and dark brown in sub-surface horizon (Table 1).

The data on particle-size distribution indicated that sand is the major fraction (43.50 to 65.30 per cent) in all the soils. The silt content in the soils ranged from 14.59 to 34.37 per cent. It increased with gentler slope and depth. This could be attributed to the fact that finer particles are washed away from the upper reaches and carried to gentler slopes. The clay content in the soils varied from 10.26 to 25.73 per cent and did not show definite trend with slope but increased with depth.

The bulk density of the soils varied from 1.28 to 1.67 Mg m^{-3}. Particle density ranged from 2.51 to 2.66 Mg m^{-3}. The data show that moisture retained at 33 kPa ranged from 6.60 to 13.57 per cent and from 3.23 to 7.36 per cent at 1500 kPa. Clay content had a positive effect on the amount of moisture retained at both the extremes. Similar results have been reported by Balpande *et. al.* (2007). The available water content (AWC) of soils varied from 0.04 to 0.10 cm^3 cm^{-3} and did not show any relationship with slope.

The pH of soils ranged from 6.7 to 8.3 (neutral to slightly alkaline). In general the pH of the soils was higher in soils occurring on gentler slopes as compared to steeper slopes. The highest EC was noticed in the soils occurring on moderately sloping land (P7) and lowest EC are in soils of gently sloping land (P3). Calcium carbonate content ranged from 0.24 to 1.43

Table 1. Morphological characteristics of soils

Depth (cm)	Horizon	Matrix colour	Structure
P1 : Coarse-loamy Typic Ustifluvent (Nearly level land, 0-1% slope)			
0-23	Ap	10YR 3/4	m 1 sbk
23-40	2C1	10YR 3/4	m1 sbk
40-62	2C2	7.5YR 3/4	m 1 sbk
62-82	2C3	7.5YR 3/4	m 1 sbk
82-110	3C4	7.5YR 3/4	m 1 sbk
110-150	3C5	7.5YR 3/4	m 1 sbk
P2 : Coarse-loamy Fluventic Haplustept (Very gently sloping pediments, 1-3% slope)			
0-15	Ap	10YR 3/3	m 1 sbk
15-40	Bw1	7.5YR 3/4	m 1 sbk
40-60	Bw2	7.5YR 3/2	m 1 sbk
60-100	2 C2	7.5YR 3/2	m 1 sbk
100-120	3C3	7.5YR 3/2	m 1 sbk
120-135	3C4	7.5YR 3/2	m 1 sbk
P3 : Coarse-loamy Typic Haplustept (Gently sloping pediments, 3-8% slope)			
0-14	A1	7.5YR 3/4	m 2 sbk
14-40	Bw1	7.5YR 3/4	m 2 sbk
40-72	Bw2	7.5YR 3/4	m 2 sbk
72-97	Bw3	7.5YR 3/4	m 2 sbk
97-120	2C5	7.5YR 3/4	m 2 sbk
120-150	2C6	7.5YR 3/4	m 2 sbk
P4 : Loamy-skeletal Lithic Ustorthent (Moderately sloping pediments, 8-15% slope)			
0-30	Ap	10YR 3/3	m 2 sbk
P5 : Loamy Lithic Haplustept (Moderately sloping pediments, 8-15% slope)			
0-22	Ap	7.5YR 3/4	m 2 sbk
22-45	Bw	7.5YR 3/4	m 2 sbk
P6 : Fine Typic Haplustept (Moderately sloping pediments, 8-15% slope)			
0-22	Ap	10YR 3/4	m 2 sbk
22-52	Bw	7.5YR 3/4	m 2 sbk
P7 : Loamy Lithic Haplustept (Moderately steeply sloping pediments, 15-30% slope)			
0-13	Ap	7.5YR 3/4	m 2 sbk
13-33	Bw	7.5YR 3/4	m 2 sbk

per cent in different soils and it increased with depth. This could be attributed to the downward movement of calcium ions and their precipitation in sub-surface layers. Similar results have been reported by Chaudhary (1992). The organic carbon content ranged from 0.21 to 1.25 per cent. The lowest OC content (0.45%) was found in surface soils of gently sloping land (P3) while the highest (1.13%) was found on soils of very gently sloping land (P1). The exchangeable Ca^{++}, Mg^{++}, Na^{+} and K^{+} ranged between 7.27 to 14.54, 4.77 to 15.22, 0.99 to 2.04 and 0.26 to 0.53 c.mol(p+) kg^{-1} soil respectively. It is observed that soils occurring

Table 2. Physical properties of soils

Depth (cm)	Mechanical composition			Density ($Mg\ m^{-3}$)		Water content (%)		AWC (cm^3/cm^3)
	Sand (0.05-2.0 mm)	Silt (0.05-0.002 mm)	Clay (< 0.002 mm)	B. D	P. D.	33kPa	1500 kPa	
P1 : Coarse-loamy Typic Ustifluvent (Nearly level land, 0-1% slope)								
0-23	54.6	31.5	13.9	1.3	2.6	9.5	3.2	0.08
23-40	57.1	21.3	21.6	1.4	2.6	8.9	3.8	0.07
40-62	53.4	30.1	16.5	1.5	2.6	6.7	3.8	0.04
62-82	55.5	33.4	11.1	1.4	2.6	9.7	4.4	0.07
82-110	58.9	22.6	18.5	1.5	2.6	7.9	4.1	0.06
110-150	64.8	18.4	16.8	1.5	2.6	8.9	4.6	0.07
P2 : Coarse-loamy Fluventic Haplustept (Very gently sloping pediment, 1-3% slope)								
0-15	56.6	23.1	20.3	1.3	2.6	9.2	3.3	0.08
15-40	52.9	21.2	25.7	1.4	2.6	11.2	5.6	0.08
40-60	60.9	24.6	14.5	1.4	2.6	11.4	4.6	0.10
60-100	55.5	28.9	15.6	1.4	2.6	12.2	6.2	0.09
100-120	58.0	24.3	17.7	1.6	2.6	12.8	6.3	0.10
120-135	59.6	23.4	16.9	1.5	2.6	8.7	4.4	0.07
P3 : Coarse- loamy Typic Haplustept (Gently sloping pediment, 3-8% slope)								
0-14	58.7	22.8	18.5	1.3	2.6	11.5	5.4	0.08
14-40	59.5	21.0	19.4	1.3	2.6	11.5	5.9	0.07
40-72	55.1	25.2	19.7	1.3	2.6	11.7	6.4	0.07
72-97	55.8	23.4	20.8	1.4	2.6	10.1	5.2	0.07
97-120	55.7	27.3	17.0	1.3	2.6	12.4	7.3	0.07
120-150	50.4	24.5	25.1	1.4	2.6	13.6	7.4	0.09
P4 : Loamy-skeletal Lithic Ustorthent (Moderately sloping pediment, 8-15% slope)								
0-30	59.6	30.1	10.3	1.5	2.6	11.1	4.9	0.09
P5 : Loamy Lithic Haplustept (Moderately sloping pediment, 8-15% slope)								
0-22	61.2	14.6	24.2	1.6	2.6	8.5	3.9	0.07
22-45	43.5	31.3	25.3	1.7	2.5	9.1	3.5	0.09
P6 : Fine-loamy Typic Haplustept (Moderately sloping pediment, 8-15% slope)								
0-22	62.2	20.8	17.6	1.2	2.6	11.1	6.6	0.06
22-52	57.6	25.8	16.6	1.4	2.7	10.5	4.8	0.08
P7 : Loamy Lithic Haplustepts (Moderately steeply sloping pediments, 15-30% slope)								
0-13	59.0	19.5	21.5	1.4	2.6	6.7	3.2	0.05
13-33	54.9	24.0	21.1	1.5	2.6	9.6	4.4	0.08

on moderately sloping pediment (P5) had the highest Ca content followed by soils over very gently sloping pediment (P2). In general, these cations increased with depth. The cation exchange capacity (CEC) varied from 14.65 (P3) to 31.38 (P5) cmol (p+) kg^{-1} soil and increased with depth (Table 3). Giri *et. al.* (1993) also reported similar findings in alluvial fan region of Ghaggar river There was no definite relationship between CEC and landform.

Table 3. Chemical characteristics of the soils

Depth (cm)	pH (1:2.5)	EC (1:2.5)	CaC03 (%)	O. C. (%)	Exchangeable bases				CEC
					c.mol (p+) kg^{-1} soil				
					Na+	K+	Ca++	Mg++	
P1: Coarse- loamy Typic Ustifluvent (Nearly level land, 0-1% slope)									
0-23	7.2	0.3	0.2	1.1	1.8	0.5	9.8	7.0	19.2
23-40	7.2	0.3	0.7	0.6	1.5	0.5	10.2	4.8	17.1
40-62	8.2	0.2	0.7	0.5	1.5	0.4	10.0	8.9	20.8
62-82	7.7	0.3	0.7	0.4	1.9	0.3	11.1	7.3	20.8
82-110	7.4	0.3	0.8	0.5	1.4	0.3	11.7	11.2	24.5
110-150	7.5	0.3	0.6	0.4	1.8	0.3	10.8	7.5	21.3
P2 : Coarse- loamy Fluvetntic Haplustept (Very gently sloping pediment, 1-3% slope)									
0-15	7.3	0.4	1.1	0.7	1.1	0.3	10.4	3.2	15.2
15-40	6.9	0.3	0.9	0.7	1.4	0.3	10.7	2.5	14.9
40-60	6.8	0.3	0.9	0.5	1.8	0.3	11.1	2.3	15.7
60-100	7.2	0.2	0.9	0.6	2.1	0.3	12.0	2.4	16.9
100-120	7.4	0.2	1.0	0.5	2.0	0.3	11.4	4.3	18.1
120-135	7.4	0.5	1.1	0.6	2.3	0.3	13.2	3.2	19.0
P3 : Coarse- loamy Typic Haplustept (Gently sloping pediment, 3-8% slope)									
0-14	7.14	0.28	0.71	0.45	1.09	0.31	8.18	6.13	15.95
14-40	7.16	0.27	1.05	0.26	1.10	0.30	7.27	5.91	14.65
40-72	7.51	0.28	1.02	0.24	1.22	0.29	8.18	5.91	15.78
72-97	7.77	0.21	1.09	0.21	1.54	0.28	10.00	5.45	17.38
97-120	7.85	0.21	1.43	0.31	1.48	0.27	10.00	9.09	20.92
120-150	8.25	0.21	1.33	0.26	1.39	0.32	11.36	5.68	18.86
P4 : Loamy- skeletal, Lithic Ustorthent (Moderately sloping pediments, 8-15% slope)									
0-30	7.13	0.27	0.71	0.73	0.99	0.32	13.18	10.68	25.24
P5 : Loamy Lithic Haplustept (Moderately sloping pediments, 8-15% slope)									
0-22	7.1	0.2	1.0	0.9	1.3	0.4	14.1	9.5	25.4
22-45	7.2	0.2	1.0	0.8	1.4	0.3	14.3	15.2	31.4
P6 : Fine- loamy Typic Haplustept, (Moderately sloping pediments, 8-15% slope)									
0-22	6.8	0.3	0.8	1.2	1.7	0.3	10.7	6.8	19.6
22-52	6.7	0.3	0.7	0.9	1.5	0.3	11.4	8.2	21.4
P7 : Loamy Lithic Haplustept (Moderately steeply sloping pediments, 15-30% slope)									
0-13	7.5	0.3	1.0	1.1	1.6	0.4	12.9	11.6	26.6
13-33	7.7	0.3	1.0	0.7	1.9	0.3	12.9	10.7	26.0

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