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MOISTURE CHARACTERISTICS OF ARIDISOLS AND THEIR RELATIONSHIP WITH SOIL PROPERTIES AND MINERALOGY

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ABSTRACT

Nine soil pedons representing a range of arid zone soils of western Rajasthan were studied for various moisture characteristics. In general, water holding capacity, field capacity, moisture equivalent and available water capacity were the function of particle size fractions, exchangeable sodium percentage and organic matter content. Magnitude of increase in AWC did not show an increase in line with increase in clay content. The very fine sand content also showed significant positive correlation with moisture characteristics. The differential moisture release pattern was explained by mineralogy of soil clays.

INTRODUCTION

Sustained crop production requires an integrated look at the dynamics of water in soil-plant-atmosphere continuum. Amongst these, soil acts as a reservoir to supply water to growing plants. The present study was thus undertaken to find out water holding capacity, field capacity, moisture equivalent, permanent wilting point, moisture retention and release characteristics and available water capacity of some dominant soils ofJodhpur and Nagaur district of Rajasthan.

MATERIAL AND METHODS

Nine pedons from dominant soils of Jodhpur and Nagaur districts (Anonymous, 1982), which varied in morphology, physico-chemical and mineralogical properties were selected for the study. Samples from each horizon were collected and after air drying soil (2 mm passed) was analysed for different properties (Table 1) and moisture parameters (Table 2) following the procedures of Piper (1950) and Jackson (1958). Moisture release curves were drawn by estimating moisture held at various suctions using pressure plate apparatus. Available water capacity (AWC) was calculated by multiplying the differential amount of moisture held at 1/3 atmosphere and 15 atmosphere with bulk density of the sample.

Table 1. Range of important physico-chemical characteristics of the soils

Soil series	pH 1 : 2	EC 1 : 2 μmhos/cm	OC %	ESP	Fine sand %	Very fine sand %	Silt %	Clay %
Dune	8.2-8.4	127-255	.06-.08	7.8-16.7	90-92	6-8	1.0-2.2	1.9-2.2
Shergarh	8.2-8.7	130-230	.06-.08	4.3-7.6	76-84	11-17	5.3-7.1	3.7-5.1
Relict	8.2-9.6	332-1480	.01-.08	6.7-67.3	51-68	18-31	5.4-14.0	4.6-16.3
Chirai	8.2-8.4	122-312	.06-.16	23.7-32.6	60-69	20-26	5.4-11.0	3.6-10.3
Gajsinghpura	8.1-8.3	216-348	.36-.40	8.1-14.6	27-30	24-31	15.0-20.8	17.6-33.0
Asop	8.6-9.5	300-1800	.16-.23	15.5-60.9	25-28	31-36	21.3-26.1	28.4-34.3
Pipar	7.8-8.0	120-300	.28-.32	0.8-4.5	23-28	23-30	18.2-20.0	17.5-27.0
Pali	8.0-8.1	714-1021	.37-.49	2.3-3.0	11-17	18-26	37.2-39.9	28.9-43.1
Palaripichkia	8.2-8.3	152-300	.11-.22	4.7-12.0	15-[illegible]9	4-22	3.5-11.2	8.9-19.5

RESULTS AND DISCUSSION

Perusal of data in Tables 1 and 2 reveals a wide variation in moisture characteristics and soil properties.

Water holding capacity (WHC) which varied between 25 to 63% (Table 2) was found to correlate significantly positive with silt (0.628), clay (0.620) and ESP (0.613) and negatively with coarse sand (0.695). Soils (Dune, Relict, Chirai) though sandy, had comparatively high WHC. This may be due to high ESP (Table 1) or dominance of Na saturated smectite clay (Choudhari and Dhir, 1982) as also reported by Kutilek and Semotan (1975) and Thomas and Moody (1962). Multiple regression equation, $WHC=90.1-0.6\ S+0.64VFS-0.13Si-0.23C-46.8\ OC+1.78\ ESP$ showed that 84% of variation was accountable to these six factors (S=sand, VFS= very fine sand, Si=Silt, C=Clay, O.C=Organic carbon, and ESP=exchangeable sodium percentage).

Field capacity (FC, moisture held at 1/3 atm) varied between 1.7 to 33.5%, showed a significant positive correlation with very fine sand (0.605), silt (0.776), clay (0.885) and organic carbon (0.675) indicating thereby more influence of particle size fractions than other soil parameters. Sharma and Jagan Nath (1979) also reported similar relationship for some Haryana soils. The equation, $FC=25.4+2.32\ S+0.59$

Table 2. Moisture eharacteristics of the soils

Soil	Water holding capacity (%)	Field Capacity (%)	Permanent wilting point (%)	Moisture equivalent (%)	Available water capacity (%)
Dune	24.6-25.2	1.4-1.9	0	1.5-2.0	2.0-2.6
	(24.9)	(1.7)	(0)	(1.8)	(2.4)
Shergarh	25.5-27-0	4.1-6.7	0.5-1.0	3.8-4.2	5.5-9.0
	(26 1)	(5.6)	(0.9)	(2.4)	(7.8)
Relict	38.4-45.9	11.4-20.3	5.4-11.2	6.9-18.3	7.2-12.5
	(42.9)	(15.7)	(7.6)	(13 5)	(10.0)
Chirai	25.0-33.2	14.3-16.9	0.3-2.1	4.5-5.9	21.8-23.8
	(30.0)	(16.1)	(1.5)	(5.3)	(22.2)
Gajsingh-pura	27.8-37.5 (33.9)	12.3-23.9 (19.8)	7.6-11.2 (9.4)	10.1-16.9 (13.3)	10.1-16.9 (14,0)
Asop	38.9-63.5	29.0·39.9	12.0-18.8	16 9-38.0	23.5-27.5
	(50.7)	(33.5)	(14.6)	(24 5)	(25.8)
Pipar	29.1-37.0	17.7-29.8	6.5-8.6	10.7-16.6	16.7-31.9
	(33.0)	(23.2)	(7.4)	(13.7)	(22.5)
Pali	40.5-45.7	24.5-29.8	9.1-16.2	19.0-25.6	11.4-27.9
	(43.5)	(26.5)	(12.6)	(23.4)	(18.6)
Palari-picbakia	22.5-26.7 (23.5)	3.9-13.5 (7.1)	0.2-3.6 (1.4)	4.4-12.0 (6.4)	4.8-14.2 (8.9)

Figures in parantheses are mean values.

VFS + 0.56 Si+0.60C-3.97OC +0.98 ESP indicated that 83% variation in FC was due to particle size fractions.

Permanent wilting point (moisture content at 15 atm), which is lower limit of available soil water, varied widely (0-18.9%) amongst the soils and within soil. PWP showed significant positive correlation with silt (0.796), clay (0.815) organic matter (0.677) and ESP (0.475). Further, sandy soils (Dune, Shergarh and Chirai except Relict) held practically no moisture at this point. Relict soil contained 5.4 to 11.2% moisture in profile which could be due to presence of sodium saturated smectite as also evidenced by high pH and ESP (Table 1) could have retained moisture as film more tenaceously. Eighty five percent of the variation observed could be attributable to the four factors as also evidenced by equation. PWP = 45.98 -0.49 S - 0.41 VFS-0.36 Si-0.37 C+7.9 OC+1.03 ESP.

Moisture equivalent (ME), an index of available moisture content, also varied widely in these soils (Table 2). Amongst the soil factors, silt and clay content showed a very high positive correlation (0.858 and 0.877) which may be due to greater influence of these on pore size distribution (Abrol, et al, 1968). Regeression equation also show that 89% of the variation is accountable to the factors studied (ME= 20.01-0.18 S-0.25 VFS+0.17 Si +0.08 C-4.73 OC + 0. 13 ESP).

Available water capacity (AWC) varied widely (2 - 23 cc/100cm) in sandy soils (Dune Shergarh and Chirai) compared to medium and fine textured soils (Gajsinghpura, Pipar, Asop and Pali), where it varied between 10.1 to 31.9 cc/ 100cm. Further, data showed that AWC although increased with increase in clay content but the magnitude of increase over 20% clay did not follow the same trend as for below 20%. Sharma and Verma (1972) also found similar trend, but for clay content over 60%. Besides correlating significantly with clay, AWC also correlated significantly with very fine sand and silt content.

Moisture release characteristics curves (Fig. 1 A and B) showed that the moisture content at any metric suction through out the range (1/3 to 15 at.) are highest in fine textured soils (Fig.1B curve C to F) and lowest in sandy Chirai, Shergarh, and Dune soils (Fig 1A, curve A to C). Relict although sandy, however, showed a high moisture content at 15 bar (Fig. 1A curve E) could be due to presence of Na saturated smectite which retains moisture more tenanceously. The moisture release curves of Pali, Gajsinghpura, Palaripichkia (curve F, D and B on fig. 1B) and Chirai (curve G on Fig. 1A) and Palaripichkia (curve B on 1B) showed different release pattern inspite of having same amount of clay (Table 3). The differential release pattern could be due to mineralogical composition (Ali and Biswas, 1971) of soils (Table 3). Further, dominance of smectite minerals in Palaripichkia and Pali led to slow release of moisture and higher retention at 15 bar (curve B and F on Fig. 1B) compared to

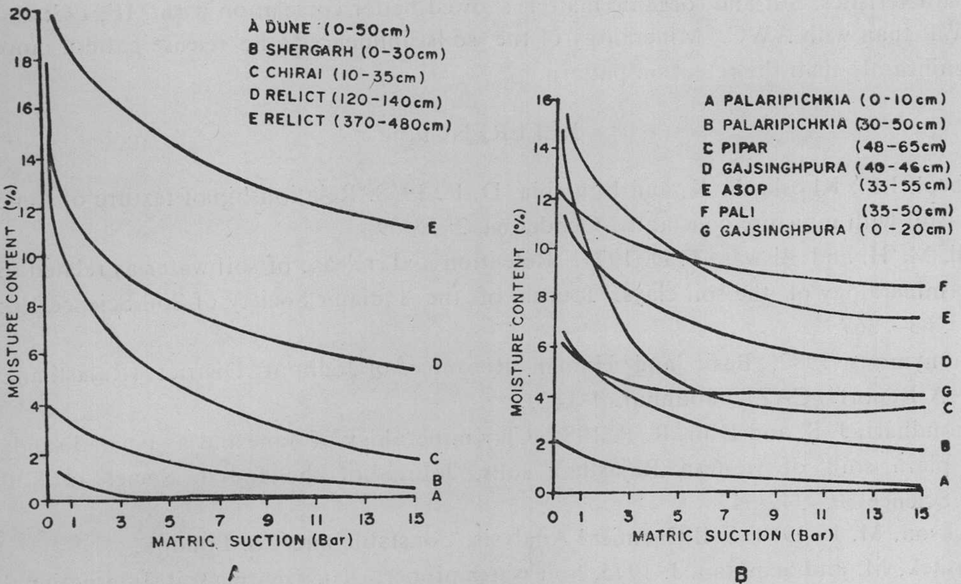

Fig. 1. MOISTURE RELEASE CURVES OF ARIDISOLS

Table 3. Moisture retention and mineralogy of the soils

Soil	Clay	% moisture at suction					Mineralogy*
	%	1/3	5	8	10	15	
Chirai	8.8	16.9	4.4	3.35	2.9	1.8	$Sm^3Mi^4Ka^1V^1$
Palari-Pichkia	9.0	3.7	2.4	1.8	1.2	0.6	$Sm^1Mi^3Ka^2V^1$
Gajsingh-pura	17.6	13.8	12.5	11.6	11.0	7.6	$Sm^3Mi^4Ka^1V^2$
Palari-pichkia	19.0	15.5	6.2	4 7	4.1	3.6	$Sm^2Mi^3Ka^1V^2$
Gajsingh-pura	33.0	23.0	17.7	17.0	11.0	10.1	$Sm^3Mi^3Ka^1V^2$
Pali	32.6	25.0	22.7	20.1	19.2	16.2	$Sm^4Mi^3Ka^1V^2$

*Sm = Smectite, Mi = mica, Ka = Kaolinite, V = Vermiculite
1 = 1-10%, 2 = 10-20%, 3 = 30-40%, 4 = 40-50%.

curve A on 1 B of Palaripichkia soil where kaolinite and mica dominated other minerals.

The results thus showed that besides particle size fractions, organic matter and ESP also have a high order of influence on moisture retention characteristics of arid soils. The results although corroborates the finding of Velayutham and Raj (1977) that sand has the negative influence on moisture retention but in arid soils very fine sand (0.1 to 0.05 mm) fraction showed a significant positive correlation with moisture characteristics. Silt and organic matter showed better correlation with ME, FC, and PWP than with AWC. Mineralogy of the soils influenced the release pattern more significantly than the retention pattern.

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