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MOISTURE RETENTION CHARACTERISTICS AND AVAILABLE WATER CAPACITIES OF CERTAIN SOIL SERIES

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ABSTRACT

Clay, organic matter content and bulk density of certain soil series were related to moisture retention at different tensions.

Key Words : Moisture Retention Characteristics, Available Water Capacities.

Relationship of soil water potential with other physical parameters and with soil water content are required for many soil water related investigations such as conservation, drainage, solute migration, irrigation scheduling, plant growth, etc. Hence an attempt has been made in this paper to assess this relationship between soil moisture tension and available water capacities of some soil series pertaining to Vertisols.

MATERIALS AND METHODS

Twenty soil samples from surface and subsurface layers were collected from ten important bench mark profiles in Madurai district in Tamil Nadu. Mechanical composition of soil was carried out as per International pipette method (Piper 1966). Soil samples screened through 2 mm sieve were saturated with excess water overnight and desorbed at varying pressure increments viz. 0.1, 0.33, 1.0, 3.0, 5.0, and 15.0 bars with the help of pressure plate apparatus. Undisturbed soil cores drawn with the help of core sampler were used for estimation of bulk density (BD).

Available water capacity (AWC) expressed as cm/100 cm soil depth at different bars was calculated by the equation,

$$\text{AWC (cm/100 cm)} = \frac{\text{(Moisture (\%) at given suction)} - \text{Moisture (\%) at 15 bar}}{100} \times \text{BD} \times 100$$

and available water percentage by subtracting 15 bar moisture percentage from 0.33 bar moisture percentage.

Organic carbon was estimated by the Walkely and Black (1934) method. Aggregate stability index was worked out as per conventional method (Black, 1965) simple correlations were worked out.

RESULTS AND DISCUSSION

Moisture Retention Characteristics :

Texturally the soil samples belonged to sand (S.No.1 and 17), loamy sand (S.No.5,7,8, and 15), sandy loam (S.No. 3, 4, 11, 12, 18 and 19), sandy loam (S.No. 2, 6, 9, 13, 14 and 16) and sandy clay (S.No.20) groups. The organic matter ranged from 0.10 to 1.81 per cent. The bulk density ranged from 1.40 to 1.89 g/cc. The aggregate stability index ranged from 3.93 to 62.40 (Table 1).

In general, the subsurface soil layers (horizons) retained appreciably higher percentage of water evidently because it is not subjected

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Table 1. Practicle-Size distribution of surface and subsurface samples

Sl. No.	Soil series	Depth cm.	Bulk density g/cc	Stability index	Moisture retention %						
					0.1	0.33	1.0	3.0	5.0	10.0	15.0
1.	Irugur	0-13	1.89	3.9	18.37	15.14	13.48	11.56	9.61	7.63	7.01
2.		13-25	1.67	11.3	21.40	16.17	13.61	13.16	12.83	8.13	7.84
3.	Ammapattai	0-17	1.55	25.3	31.34	18.16	11.22	10.33	9.25	7.63	7.24
4.		17-35	1.66	38.0	24.20	17.95	15.00	14.67	12.04	6.87	5.40
5.	Palathurai	0-20	1.70	36.9	17.54	11.26	9.86	9.73	9.55	7.29	6.61
6.		20-51	1.71	25.0	20.80	15.76	14.35	13.46	12.37	11.12	10.40
7.	Dindugal	0-21	1.55	26.6	17.04	10.61	9.43	8.50	8.00	3.93	3.31
8.		21-38	1.40	26.8	17.60	10.00	8.14	7.50	7.09	4.12	3.64
9.	Madukkur	0-15	1.78	53.3	20.56	14.81	13.75	11.22	10.04	8.12	7.45
10.		15-35	1.68	16.0	21.61	14.57	13.27	11.99	11.54	10.84	10.20
11.	Padugai	0.29	1.63	37.4	27.98	13.46	12.79	12.14	12.12	10.80	7.14
12.		29-66	1.53	53.3	28.80	14.49	12.34	11.26	10.18	10.00	9.55
13.	Vyalogam	0-20	1.52	10.1	17.05	12.66	10.09	8.14	6.09	5.92	5.67
14.		20-51	1.66	40.1	22.21	15.90	11.55	9.55	8.19	7.86	6.30
15.	Anaiyur	0-19	1.80	16.2	7.56	5.58	4.47	3.61	2.04	2.00	1.88
16.		19-50	1.75	20.3	17.24	11.50	8.58	6.44	5.28	5.00	4.55
17.	Araiyur	0-17	1.41	12.3	6.25	5.50	4.25	4.00	3.83	3.80	3.75
18.		17-35	1.70	28.7	27.73	16.42	14.53	12.83	11.67	8.53	8.21
19.	Palladam	0-15	1.83	12.8	16.57	6.84	6.45	5.73	5.50	5.00	4.49
20.		15-39	1.44	62.4	18.75	14.06	13.12	12.61	11.24	10.48	9.74

Table 2. Correlation Coefficients (n=20)

S. No.	Properties Moisture tension	Clay %	Clay+Silt %	Organic matter	Bulk density	Sand %
1.	0.1 bar	0.313	0.792**	0.031	-0.462*	-0.375
2.	0.33 bar	0.646	0.969**	0.010	-0.471*	-0.516*
3.	1.0 bar	0.504	0.923**	0.096	-0.501*	-0.576**
4.	3.0 bar	0.500**	0.872**	0.065	-0.343	-0.456*
5.	5.0 bar	0.555**	0.914**	0.188	-0.206	-0.475*
6.	10.0 bar	0.595**	0.926**	0.024	-0.257	-0.578**
7.	15.0 bar	0.599**	0.907**	0.065	-0.284	-0.563**
8.	Available water	0.188	0.558**	0.906	-0.428	-0.619**

* Significant at 5% level
** Significantal 1% level

Table 3. Regression equations for important parameters

Sl. No.	Particulars	Regression equation
1.	Clay Vs. 1/3 bar moisture	Y = 7.5 + 0.27 x
2.	Clay Vs. 15 bar moisture	Y = 3.2 + 0.16 x
3.	Clay + slit Vs. 1/3 bar moisture	Y = 4.7 + 0.36 x
4.	Clay + slit Vs. 15 bar moisture	Y = 1.6 + 0.21 x
5.	Clay + slit Vs. Avail water	Y = 3.0 + 0.15 x
6.	Oganic matter Vs. Available water	Y = 3.2 + 6.25 x
7.	Bulk density Vs. 1/3 bar moisture	Y = 34.5 - 13.13 x
8.	Bulk density Vs. Available water	Y = 20.0 - 8.26 x
9.	Sand Vs. Available water	Y = 19.0 - 0.17x

to evaporation and less subjected to plant removal. This is in line with the observations of Choudhry and Miller (1983). Graphically represented, the different textural groups revealed that at any moisture tension, finer the texture, more is the percentage of moisture retained by the soil. There was a good correlation between clay content and the moisture retention percentage. This is in line with the findings of Cock (1985), Mathew and Nair (1985) and Zhang and Miao (1985). When correlation was worked out for clay plus silt, the "r" values appreciably improved, indicating the cotributions of silt fractions also in the retention of moisture. Clay contents correlated positively with 1/3 and 15 bar moisture per cent. But there was no correlation with available moisture. When correlation with clay plus slit was worked out with available moisture, there was significant correlation (r = 0.558*). This indicates that silt is important for retaining more of available water. Water retention at tensions lesser than one is higher when compared to those at 10 and 15 bars. Variations in water retention percentage at lower tensions were higher when compared to those at higher tensions. Sand percentages have correlated negatively with soil moisture retention at all regimes except 0.1 bar.

Organic matter content in these soils did not significantly correlate with the moisture retention percentage at any of the tension levels upto permanent wilting point. However there was a very high collection (r = 0.906**) with the

Table 4. Percentage depletion of moisture at every state of moisture tension. (Bars)

S. No.	From 0.1 to 0.33	From 0.33 to 1.0	From 1 to 3	From 3 to 5	From 10 to 15	Available water capacity (cm) 0.1	0.33	1.0	3.0	5.0	10.0	Available water %
1.	17.6	11.0	14.2	16.9	8.1	21.5	15.4	12.2	8.6	4.9	1.2	8.1
2.	24.4	15.8	3.3	2.6	3.6	22.7	15.6	9.6	8.9	8.3	0.5	9.3
3.	43.8	38.0	7.9	1.0	5.1	38.9	16.9	6.2	4.8	3.1	0.6	10.9
4.	25.8	16.4	2.2	1.8	2.1	31.2	20.8	15.9	15.4	11.0	2.4	12.6
5.	35.0	12.4	1.3	1.8	9.3	18.5	7.9	5.5	5.3	5.0	1.2	4.7
6.	24.2	8.9	6.2	8.1	8.7	18.3	9.6	7.2	5.7	3.8	1.7	5.6
7.	37.7	11.1	9.9	5.9	15.6	21.2	11.3	9.5	8.0	7.3	0.9	7.3
8.	43.2	18.6	7.9	5.5	11.6	14.0	8.9	6.3	5.4	4.8	0.7	6.4
9.	28.0	7.2	11.1	1.5	8.3	13.6	13.1	11.2	8.5	8.2	1.2	7.4
10.	32.6	8.9	9.6	23.8	5.9	20.3	7.3	5.2	3.0	2.3	1.1	4.4
11.	51.9	5.0	5.1	0.2	3.4	34.9	10.3	9.2	8.2	8.1	6.0	6.3
12.	49.7	14.8	9.6	8.6	4.5	31.5	7.6	4.3	2.6	1.0	0.7	4.9
13.	25.7	20.3	19.3	25.2	4.2	17.4	10.6	6.7	3.8	.6	0.4	7.0
14.	28.4	27.4	17.3	14.2	19.8	24.2	15.9	8.7	5.4	3.1	2.6	9.6
15.	26.2	28.9	19.9	19.2	6.0	10.3	6.7	4.7	5.4	3.1	2.6	9.6
16.	36.2	22.0	24.9	18.0	9.0	22.2	11.3	7.1	3.3	1.3	0.8	6.5
17.	19.2	15.3	5.9	4.3	1.3	3.5	1.8	0.7	0.4	0.1	0.1	1.3
18.	40.8	11.5	11.3	9.5	3.8	33.2	14.0	10.7	8.0	5.9	0.5	8.2
19.	58.7	20.3	11.2	4.0	10.2	22.1	4.3	3.6	2.1	1.8	0.9	2.4
20.	25.0	6.7	3.9	10.9	7.1	12.9	6.0	4.9	4.1	2.2	1.1	4.3
Mean	33.7	16.0	10.0	8.2	7.4	21.93	10.7	7.5	5.7	4.3	1.2	6.5

available water per cent. Thulasidaran and Nair (1984) obtained a positive correlation with organic matter.

The moisture retention percentages at all the seven different tensions were negatively correlated with the bulk density of soils. However the "r" values are significant at tension less than 1 bar. Further there was a significant negative correlation ($r = -0.428^{*}$) with available water content. This indicated that structure and pore size distribution as indirectly evidenced by its manifestation through bulk density play a major role in retaining water and availing water to plants. Ohu *et al.* (1985) observed similar trends.

Available water capacity

The available water capacity decreased progressively towards the dry end, the fall being very steep and sharp near the wet end and smooth and gradual towards the dry end indicating that the water on the soil surface are depleted at the dry end while soil structure and aggregates hold water freely at the wet end.

Correlations were worked out for the AWC against clay, clay plus silt, organic matter and bulk density. The results indicated that there was no significant correlation of AWC with clay, organic matter and bulk density. But when correlation was worked out between silt plus clay and AWL, it was significant at wet ranges ($r = 515^{*}$ at 0.33 bar moisture tension and 0.40 at 1.0 bar moisture tension). This was in line with the observations of Mishra and Nanda (1985). This again implied that silt fraction contributed for the water holding capacity. At dry end there was no significant correlation.

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