Moisture Characteristics of Some Representative Indiana Soil Types

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The capacity of soils to absorb and store water is of interest to agronomists, engineers, and other associated with soils. However, soils differ in their water holding characteristics, ranging from ½ inch per foot for the coarse textured soils to over 2½ inches for the fine textured soils. In the layman's terminology, soils may be classified as droughty, not so droughty, or one having a good moisture supply. This is not adequate for our modern day agriculture, especially with the knowledge and techniques now available for determining soil physical properties.

The development of the energy concept of soil moisture has been helpful in describing the condition of soil water. It has given us a quantitative evaluation for the recommendation of many agronomic practices.

This paper is a progress report, presenting data relative to the determination of the moisture characteristics of some typical Indiana soil types. To date about 50 soils have been sampled and analyzed. Three representative soils are described and a more detailed report will be published in the near future.

During the initial phases of the project, soils which were low in moisture holding capacity were selected. These were considered as most probable for irrigation. More recently, other soils have been included, particularly those which encompass a significant area in Indiana. Samples were taken in a depth profile to secure the information from all the horizons. Several soils have been sampled at more than one location. It is always difficult to select sites which truly represent the soil type desired.

Characterizing soil water involves two major factors. The first of these is moisture content and is a capacity factor. Moisture content is usually expressed in per cent by weight based on oven dry soil. The second is an intensity factor and concerns the energy with which the moisture is held by the soil. It can be defined as the work per unit mass of water required to remove moisture from the soil. Since in the c.g.s. system, the density of water is unity, the work term is equal to pressure. This energy term is denoted as tension or suction in centimeters of water, centimeters of mercury, atmospheres, or as bars. Relating the capacity factor of a soil to the intensity factor is the moisture characteristic. Each soil has its own peculiar characteristic.

Two points which are of particular interest on the soil moisture characteristic curve are Field Capacity and Permanent Wilting Percentage. Although these are not exact points, they are extremely useful from a practical point of view. Field Capacity has been defined as the moisture content of the soil when after application of water internal drainage has essentially ceased, and the Permanent Wilting Percentage as the soil moisture content when plants fail to regain leaf turgidity when in a

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saturated atmosphere. The soil water between Field Capacity and Permanent Wilting Percentage is available to the plant and is a capacity term rother than an intensity. In other words, this available water is not necessarily equally available to the plant.

The one-third atmosphere percentage has been an accepted estimate of Field Capacity. This estimate is not accurate for all soil textures, one-tenth atmosphere suction is more nearly correct for the sandy soils and one-half atmosphere suction for the clay type. The fifteen atmosphere percentage has been found to correlate quite well with the wilting percentage and is most frequently used as the estimate for this constant.

A bulk density sample was necessary for each soil horizon for the conversion of soil moisture content from a per cent by weight to a per cent by volume. A modified Lutz sampler was used for obtaining this measure. After securing the per cent by volume, a simple multiplication of this value by the depth of soil gives the depth of water. This is shown in the equation:

$$d_w = \frac{B_d}{W} \times \frac{P_w}{100} \times D_s$$

Where d_w = depth of water
B_d = bulk density of the soil
W = density of water
P_w = per cent moisture on a dry weight basis
D_s = depth of soil

The Lutz type sampler was also used for taking the undisturbed soil cores for the lower range of desorption suctions. The 50, 100, 200, and 345 centimeters (one-third atmosphere) of water suctions were measured on a pressure plate apparatus. The 1, 5, 10, and 15 atmosphere percentage values were determined with disturbed samples on the pressure membrane appartus.

Data for three soils, namely, Fincastle silt loam, Warsaw silt loam, Coloma loamy sand are given in Tables 1, 2, and 3 respectively. The desorption information is shown in Tables 1a, 2a, and 3a for each horizon. This data along with the bulk density gives rise to the soil moisture characteristics presented for the respective soils in Tables 1b, 2b, and 3b. The inches of water per inch of soil at the two moisture constants is given, in addition to the total depth of water in each horizon. The left hand column is an estimate of the available water in the horizon.

A practical application for this information is illustrated with the Fincastle silt loam in Figure 1. The plants can only utilize the available soil water from those horizons into which its roots penetrate. The number of inches in the upper right hand corner of each section indicates the amount of water available to the plant with the root characteristics shown.

Soil moisture characteristic data can be used for several purposes. By relating this information to the capillary rise equation, pore size distribution can be determined. With moisture characteristics of experimental soils, research workers can more accurately evaluate the moisture variable. Agricultural extension workers, Soil Conservation Service personnel, Farm Home Administration supervisors and land appraisers can make a sounder recommendation to their cooperators and clients with a

Table 1a. Fincastle silt loam

SOIL MOISTURE DESORPTION DATA

Horizon	Depth (inches)	Bulk Density (gm/cc)	Percent Water at Respective Tensions							
			50 Cm. of H_2O	100 Cm. of H_2O	200 Cm. of H_2O	1/3 Atm.	1 Atm.	5 Atm.	10 Atm.	15 Atm.
A_p	0–6	1.25	30.1	28.8	27.3	26.2	20.5	10.0	7.8	7.1
A_2	6–11	1.43	25.7	24.8	24.0	23.5	20.3	11.6	8.8	7.7
B_1	11–17	1.42	26.3	25.9	25.2	24.9	22.1	15.8	13.8	12.3
B_{21}	17–24	1.41	28.3	28.1	27.2	26.8	22.9	16.5	14.2	13.4
B_{22}	24–29	1.50	25.4	25.6	24.5	24.1	20.8	15.1	14.1	12.8
B_{23}	29–36	1.55	23.1	22.9	21.8	21.8	19.6	14.4	13.1	12.2
B_{24}	36–43	1.53	21.3	20.7	19.9	19.6	17.8	13.4	11.7	11.1
C	43–60	1.80	14.9	14.5	14.0	13.8	13.6	10.2	7.7	7.5

Table 2a. Warsaw silt loam

SOIL MOISTURE DESORPTION DATA

Horizon	Depth (inches)	Bulk Density (gm/cc)	Percent Water at Respective Tensions							
			50 Cm. of H_2O	100 Cm. of H_2O	200 Cm of. H_2O	1/3 Atm.	1 Atm.	5 Atm.	10 Atm.	15 Atm.
A_{11}	0.0–2.5	1.06	35.8	33.6	31.8	29.7	24.3	16.4	12.9	12.6
A_{12}	2.5–12.5	1.16	30.8	28.9	27.4	25.5	22.5	15.5	13.8	12.8
B_1	12.5–16.0	1.28	27.6	26.4	25.3	23.6	22.1	15.5	13.6	12.0
B_{21}	16.0–20.0	1.35	26.6	25.6	24.8	23.4	22.9	16.5	14.8	14.7
B_{22}	20.0–35.0	1.47	23.0	21.5	20.9	19.8	19.0	17.1	16.6	16.2
D	35.0–48.0	1.50	16.8	15.7	14.8	13.5	12.9	11.5	9.4	8.5
D	48.0–60.0	1.62	7.4	6.8	6.1	4.3	3.8	2.7	2.3	2.0

Table 1b. Soil Moisture Characteristics
Fincastle silt loam.

Horizon	Depth (inches)	Inch Water/Inch Soil 1/3 Atm.	Inch Water/Inch Soil 15 Atm.	Total Inches Water in Horizon 1/3 Atm.	Total Inches Water in Horizon 15 Atm.	Inches Available Water in Horizon
A_p	0–6	0.33	0.09	1.97	0.53	1.44
A_2	6–11	0.34	0.11	1.68	0.55	1.13
B_1	11–17	0.35	0.18	2.12	1.05	1.07
B_{21}	17–24	0.38	0.19	2.65	1.32	1.33
B_{22}	24–29	0.36	0.19	1.81	0.96	0.85
B_{23}	29–36	0.34	0.19	2.37	1.32	1.05
B_{24}	36–43	0.30	0.17	2.10	1.19	0.91
C	43–60	0.25	0.14	4.22	2.30	1.92
					Total	9.70

Table 2b. Soil Moisture Characteristics
Warsaw silt loam.

Horizon	Depth (Inches)	Inch Water/Inch Soil 1/3 Atm.	Inch Water/Inch Soil 15 Atm.	Total Inches Water in Horizon 1/3 Atm.	Total Inches Water in Horizon 15 Atm.	Inches Available Water in Horizon
A_{11}	0.0–2.5	0.32	0.13	0.79	0.32	0.47
A_{12}	2.5–12.5	0.30	0.13	2.96	1.31	1.65
B_1	12.5–16.0	0.30	0.15	1.06	0.54	0.52
B_{21}	16.0–20.0	0.32	0.20	1.26	0.79	0.47
B_{22}	20.0–35.0	0.29	0.24	4.37	3.57	0.80
D	35.0–48.0	0.20	0.13	2.64	1.66	0.98
D	48.0–60.0	0.07	0.03	0.84	0.38	0.46
						Total . . 5.35

Table 3a. Coloma loamy sand
SOIL MOISTURE DESORPTION DATA

Depth* (Inches)	Percent Water at Respective Tensions: 100 Cms. of H_2O	1/3 Atm.	1/2 Atm.	6/10 Atm.	8/10 Atm.	15 Atm.
0–6	5.6	5.6	5.3	4.8	4.6	2.5
6–12	5.1	5.1	4.9	4.3	4.4	2.3
12–18	4.3	4.3	4.0	3.6	3.4	1.8
18–24	3.9	3.9	3.2	3.2	2.9	1.6
24–36	3.2	3.1	3.0	2.7	2.5	1.6
36–48	3.6	3.5	3.1	3.0	3.0	1.8
48–60	4.9	4.9	4.2	3.9	3.4	2.3

* Bulk density for all depths 1.50 gm/cc.

Table 3b. Soil Moisture Characteristics

Coloma loamy sand

Depth (Inches)	Inch Water/Inch Soil F.C.*	Inch Water/Inch Soil 15 Atm.	Total Inches Water in Horizon F.C.*	Total Inches Water in Horizon 15 Atm.	Inches Available Water in Horizon
0-6	0.12	0.04	0.70	0.22	0.48
6-12	0.12	0.04	0.69	0.21	0.48
12-18	0.11	0.03	0.64	0.16	0.48
18-24	0.10	0.02	0.61	0.14	0.47
24 36	0.10	0.02	1.14	0.28	0.86
36-48	0.11	0.03	1.26	0.33	0.93
48.60	0.14	0.04	1.50	0.42	1.08

* Field Capacity as determined by soil sampling.

knowledge of these soil properties. Better design of irrigation systems, and more efficient water management by the irrigation operator is possible if there is a basis for making sound decisions.

The moisture characteristic is a unique physical property of the soil, and should be included in its description.

FINCASTLE SILT LOAM

HORIZON	DEPTH (INCHES)	WATER AVAILABLE (INCHES)
A_P	0-6	1.44
A_2	6-11	1.13
B_1	11-17	1.1
B_{21}	17-24	1.33
B_{22}	24-29	0.85
B_{23}	29-36	1.05
B_{24}	36-43	0.91
C	43-60	1.92
Total Available		9.70

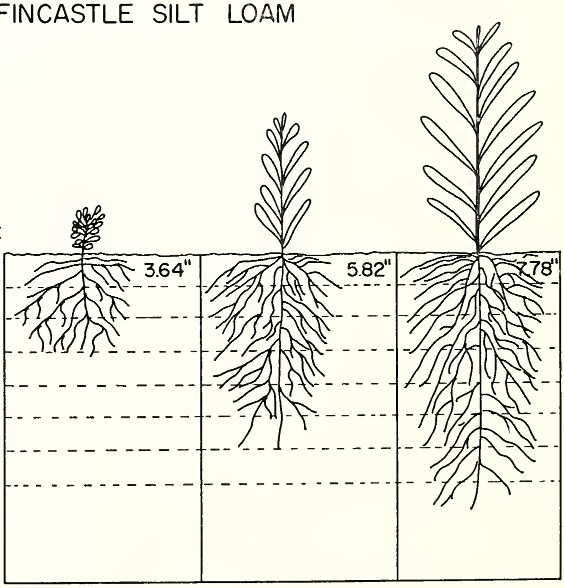

Figure 1