USDA Natural Resources Conservation Service

Irrigation Toolbox Chapter 1

Lesson Plan No. 1

Soil-Water Relationship

OBJECTIVE:

To provide participants with some basic information about the physical properties of soil and soil-water relationships.

METHOD: Lecture-Demonstration.

Soil is a storehouse of plant nutrients, a habitat for bacteria, an anchorage for plants and a reservoir that holds the water needed for plant growth. The amount of water that a soil can hold available for plant use is determined by its physical properties. This amount determines both the frequency of irrigation and the capacity of the irrigation system needed to insure continuous crop growth.

Soil Texture

Teaching Aid:

- Transparency of Fig. 1.1 and Table 1.1 pages 1.2 and 1.3, Chapter 1, Section 15, National Engineering Handbook.
- Samples of soil of different textures.

Key Points:

- Texture denotes size of soil particles.
- Sand
    - Loams
- Silts
    - Loams
- Clays
- Mucks - unrecognizable organic materials.
- Peats - recognizable organic materials.

Soil Structure

Teaching Aid:

- Transparency of Figure 1-2.

Key Points:

- Structure controls rate of water movement.
- Soil particles sometimes bound or cemented.
- Carbonates

- Bi-carbonates - Cause dispersion
- Sodium
- Calcium
- Presences of organic material can change soil structure.
- Combination of structure, texture, and organic materials control the water holding capacity of soil.

Soil Water

We want to know how much water a soil can hold available for plant use and how rapidly the water can enter or travel through the soil profile.

Teaching Aid:
- Transparency of 7-0-13000-209L

Key Point:
- Gravitational water - drains out.
- Capillary - responds to capillary or soil fringe forces, move any direction but generally toward area of greatest tension (wet to dry.)
- Hygroscopic - held to soil particles - unavailable for use.

Soil Moisture Tension

Water is held to soil by attraction. Plants must apply tension force to remove water. Tension needed varies with soil texture, structure, salt content of soil and water, and water content of soil.

Teaching Aid:
- Transparency of Figure 1-4

Available Water

Teaching Aid:
- Figures 1-5 and 1-6 on Transparency.

Key Points:
- Available water is part of capillary supply.
- Some use of gravitational water can be made in slower draining soils.
- Related to tension at soil interface.
    - Field capacity: 1/10 TO ½ atmosphere; we use 1/3.
    - Permanent wilting point - 15 atmosphere (disturbed samples.)

The moisture content and the apparent specific gravity can be determined by using the Eley Volumeter and the Speedy Moisture tester. Other methods can be used, but the use of this equipment gives the easiest, quickest results with good accuracy. However, to determine available waterholding capacities and moisture content at the permanent wilting point must be known or must be estimated. The percentages shown in the table in the handout material should be used for those soils shown. Estimates can be made for

soils not shown. This type information is available for your own local area in published soils reports or in data gathered by local soil scientists. The procedures for determining soil moisture with the Eley Volumeter and the Speedy Moisture Tester is as follows:

Equipment:

- Speedy Moisture Tester with 2 cans reagent.
- Eley Volumeter.
- EXHIBIT-IWM- 1

Teaching Aid:

- Two transparencies of above EXHIBIT for use with overhead projector.
- 1 -fullEXHIBIT
- 2 - heading and columns only.
- Copies of conversion chart. EXHlBIT - IWM -2.

Key point:

- Dig or bore hole.
- Record depth of hole or sampling horizon.
- Attach Eley Volumeter to holder.
- Take sample.
- Extrude core to vernier reading of 0.
- Extrude sample and weigh carefully, 26 grams.
- Read volume and record.
- Compute net volume and record.
- Place sample in tester and run test.
- Record wet moisture % from gage.
- Convert wet % to dry % with chart and record.
- Estimate or determine permanent wilting point - record.
- Compute moisture range Pd-p.
- Compute d_b, using the equation shown - record.
- Compute depth of moisture D in soil layer - record.
- Repeat for each soil layer of each foot of soil.
- Add last column to arrive at available moisture in root zone.

EXHIBIT-IWM-1

UNITED STATES DEPARTMENT OF AGRICULTURE
Natural Resources Conservation Service

DETERMINATION OF SOIL MOISTURE AND BULD DENSITY (DRY)
USING
ELEY VOLUMETER AND SPEEDY MOISTURE TESTER

Farm _____ Location _____ SWCD _____
Crop _____ Soil Type _____ Date _____ Tested by _____

Before Irrigation _____ After Irrigation (field capacity) _____ (check one)

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
			Volumeter			Percent Moisture					
Soil Texture	Depth of Layer (ins.)	Thickness of Layer (ins.)	Initial Reading (cc)	Final Reading (cc)	Volume (cc)	Wet Weight Percent	Dry Weight Percent	Bulk Density (dry) (grs/cc)	Total Moisture in Soil before Irr (ins.)	Total Moisture in Soil @ F.C. (ins.)	Soil Moisturte Defi-ciency (ins.)
	d				V	Pw	Pd	d_b	D_1	D_{fc}	D_n
										/ / / / / /	
									/ / / / / / / /		
										/ / / / / /	
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										/ / / / / /	
									/ / / / / / / /		
								Totals			

Wet weight of all samples 26 grams unless otherwise shown.

(1) $db = \frac{26}{V\ (1 + \frac{Pd}{100})}$ (2) $\frac{D = d_b \times Pd^* \times d}{100 \times 1}$

*Pd for total moisture

Fill out heading completely. Fill in lines in columns as tests are made.
Be neat, accurate, and make a complete record.

Column 1 Record texture of each soil layer.

Column 2 Record depth from ground surface to top and bottom of soil strata of portion of profile sampled. (12-24.)

Column 3 Thickness of layer. Difference of two values shown in Column 1. (24-12=12)

Column 4 Reading of volmeter scale **before** sample is extruded.

Column 5 Reading the volmeter scale **after** sample is extruded.

Column 6 Difference between Column 4 and 5; (Column 5-Column 4.)

Column 7 Reading of dial on Speedy Moisture Tester at completion of test. Percent moisture wet weight.

Column 8 Dry weight moisture percent from table is in Speedy Moisture Tester.

Column 9 Bulk Density. Compute from equation No. (1).

Column 10 Total Available Moisture in soil before irrigation. Use equation No. (2)

Column 11 Depth of Moisture (Dfc) in Soil at Field Capacity. Use equation No.(2).

Column 12 Moisture deficiency; (Column 11-Column 10.)

Gage Read .1/	Oven Dry Moisture -Percent									
	.0	.1	.2	.3	.4	.5	.6	.7	.8	.9
2	2.0	2.1	2.2	2.3	2.4	2.5	2.6	2.7	2.8	2.9
3	3.0	3.1	3.2	3.3	3.4	3.5	3.6	3.7	3.8	3.9
4	4.0	4.1	4.2	4.3	4.4	4.5	4.6	4.7	4.8	4.9
5	5.1	5.2	5.3	5.4	5.5	5.7	5.8	5.9	6.0	6.1
6	6.2	6.3	6.4	6.5	6.6	6.8	6.9	7.0	7.1	7.2
7	7.3	7.4	7.5	7.6	7.7	7.9	8.0	8.1	8.2	8.3
8	8.4	8.5	2.2	8.7	8.8	9.0	9.1	9.2	9.3	9.4
9	9.5	9.6	9.7	9.8	9.9	10.1	10.2	10.3	10.4	10.5
10	10.6	10.7	10.8	11.0	11.1	11.2	11.3	11.4	11.6	11.7
11	11.8	11.9	12.0	12.2	12.3	12.4	12.5	12.6	12.8	12.9
12	13.0	13.1	13.3	13.4	13.5	13.7	13.8	13.9	14.0	14.2
13	14.3	14.4	14.6	14.7	14.8	15.0	15.1	15.2	15.3	15.5
14	15.6	15.7	15.9	16.0	16.2	16.3	16.4	16.6	16.7	16.9
15	17.0	17.1	17.3	17.4	17.5	17.7	17.8	17.9	18.0	18.2
16	18.3	18.4	18.6	18.7	18.9	19.0	19.1	19.3	19.4	19.6
17	19.7	19.8	20.0	20.1	20.3	20.4	20.5	20.7	20.8	21.0
18	21.1	21.3	21.4	21.6	21.7	21.9	22.0	22.2	22.3	22.5
19	22.6	22.8	22.9	23.1	23.2	23.4	23.5	23.7	23.8	24.0
20	24.1	24.3	24.4	24.6	24.7	24.9	25.0	25.2	25.3	25.5
21	25.6	25.8	25.9	26.1	26.2	26.4	26.5	26.7	26.8	27.0
22	27.1	27.3	27.4	27.6	27.7	27.9	28.0	28.2	28.3	28.5
23	28.6	28.8	28.9	29.1	29.2	29.4	29.6	29.7	29.9	30.0
24	30.2	30.4	30.5	30.7	30.8	31.0	31.1	31.3	31.4	31.6
25	31.7	31.9	32.0	32.2	32.3	32.5	32.7	32.8	33.0	33.1
26	33.3	33.5	33.6	33.8	33.9	34.1	34.3	34.4	34.6	34.7
27	34.9	35.1	35.2	35.4	35.5	35.7	35.9	36.0	36.2	36.3
28	36.5	36.7	36.8	37.0	37.1	37.3	37.5	37.6	37.8	37.9
29	38.1	38.3	38.4	38.6	38.8	39.0	39.1	39.3	39.5	39.6
30	39.8	40.0	40.1	40.3	40.5	40.7	40.8	41.0	41.2	41.3
31	41.5	41.7	41.8	42.0	42.2	42.4	42.5	42.7	42.9	43.0
32	43.2	43.4	43.5	43.7	43.8	44.0	44.2	44.3	44.5	44.6
33	44.8	45.0	45.1	45.3	45.5	45.7	45.8	46.0	46.2	46.3

1/ Carbide Moisture Tester - 3-minute readings

Exhibit IWM-2 Carbide moisture tester conversion chard