CONSERVATION TILLAGE FACTS

On-Farm Soil Water Measurements

Knowing the amount of crop-available water in your soil will help you make a wise crop decision

When weeds, pests, nutrients, and heat units are not limiting to crop production, yield is determined by the amount of water available to the plant for growth and development. Some of that water comes from precipitation, and some comes from stored soil water. While we can't know in advance how much rain will fall during the growing season, we can know how much soil water is available prior to planting the crop. Because plants differ in how deep they root and how much water they can take from the soil, knowing how much water is available from the soil can help us make a wise crop decision, predict yield, determine depth of dry soil layers, or calculate preirrigation requirements to fill the soil profile to field capacity. Measurements of soil water can be made with a small amount of equipment and a home microwave oven.

Equipment Needed

In addition to the home microwave oven for drying the soil samples, the equipment needed to collect and process the soil samples include:

- Soil probe with handle and extensions
- Ziplock bags and permanent marker
- Balance with 0.1 gram precision
- Ceramic or glass cups or beakers

A soil probe of the type shown (back of this sheet) with extensions to allow soil sampling to 48" costs approximately $80. A balance of the type shown costs approximately $100.

Sampling the Site

You should determine the location and number of sites to be sampled by your knowledge of the uniformity of the soil types and previous plant growth on a field. Locations with different slope and position should be sampled separately.

Probe the soil to a depth of one foot, then carefully remove the probe from the soil and place the soil sample in a ziplock bag. Label the bag with the permanent marker to identify the field, location, and depth. Carefully insert the probe back into the hole and probe to a depth of two feet. Again carefully remove the probe and place the soil sample in a bag and mark it for identification. Continue probing in 1 foot depth increments until all samples are obtained. Store the samples in an ice chest (no ice needed) to protect the sample from light and temperature changes which could cause soil moisture to condense on the sides of the ziplock bag.

Processing the Sample

The soil samples must be weighed, dried, and weighed again to determine the water content. Drying the sample is the tricky part, for we want to heat the sample enough to drive off all of the water, but not so much that we burn off organic matter. The following steps should be followed:

1. Label cups to match labels on sample bags
2. Weigh and record empty cup weights
3. Mix soil in bag
4. Remove about 40 g of soil (a little less than 1/4 cup) and put in cups
5. Weigh and record weight of sample and cup
6. Put cups in warm, dry place for two days to air-dry, stirring sample once or twice during drying period
7. Put 4 to 6 soil samples in microwave
8. Cook on High for approximately 8 minutes, stopping to wipe collected moisture off cup after first 2.5 minutes
9. Weigh and record weight of sample and cup
10. Cook on High for additional 2 minutes
11. Weigh and record weight of sample and cup
12. If weights have not changed, go to calculations; otherwise cook on High an additional 2 minutes, or until

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weights do not change

A small cup of water, covered with a paper towel should be placed in a corner of the microwave oven to absorb excess microwave energy when the soil samples become dry.

During the two days of air-drying before microwaving, the sample loses approximately 75% of its water, thereby reducing the drying time in the microwave and the chances of overheating the sample. Also, the sample is less likely to "pop" as the water is being driven off, which could cause you to lose part of your soil sample.

As you do more samples, you will have a good idea how much time is required for your particular microwave to dry the soil samples to a constant weight.

Calculating the Water Content

Volumetric water content is the volume of water in a given volume of soil. Values typically range from 0.10 (dry) to 0.40 (wet). It is calculated as:

$$Volumetric\ water = \frac{(wet\ weight - dry\ weight)}{(dry\ weight - cup\ weight)} * bulk\ density$$

The bulk density is the mass of soil in a given volume of soil, and varies with soil type and depth in the soil. Bulk density can be measured by drying the entire soil core sampled and then dividing the dry weight by the length and width of the soil core. To convert the volumetric water content to inches of available water per sampled depth of soil we use the formula:

$$Available\ water\,(in) = (Volumetric\ water - lower\ limit) * depth$$

The lower limit is the volumetric water content at which soil water is unavailable to the plant. That is, the plant is unable to extract water from the soil below this volumetric water content. The lower limit can be determined from soil water measurements a similar soil where grass is growing. This value and bulk density vary with soil type (see below). Depth in the above equation is the sampling depth interval, which according to the above sampling procedure is 12 in. The following table shows some example data and calculations of volumetric water and available soil water for a four-foot soil profile. In the example, we have assumed a constant lower limit and bulk density with depth in the soil.

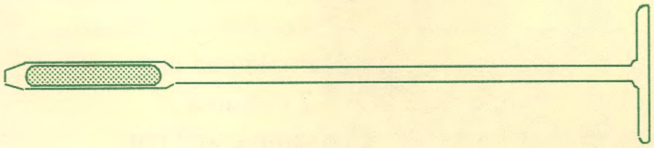
Sample Data and Calculations

Sample	cup wt (g)	wet wt (g)	dry wt (g)	bulk density (g /cm^3)	volumetric water (cm^3 /cm^3)	lower limit (cm^3 /cm^3)	soil depth (in)	available water (in)
1	45.2	82.2	75.1	1.32	**0.313**	0.108	12	**2.46**
2	46.6	87.5	80.3	1.32	**0.282**	0.108	12	**2.08**
3	43.1	85.3	79.5	1.32	**0.210**	0.108	12	**1.22**
4	44.5	82.1	78.0	1.32	**0.162**	0.108	12	**0.65**
total								**6.41**

General Soil Properties by Type

Soil type	bulk density (g /cm^3)	lower limit (cm^3 /cm^3)
sand	1.54	0.031
coarse sandy loam	1.47	0.059
loam	1.36	0.095
fine silt loam	1.25	0.113
clay	1.10	0.154

Soil Probe



Balance