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SOIL MOISTURE MEASUREMENTS BY ELECTRICAL RESISTANCE

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Since 1937, and earlier, soil scientists have been experimenting with various methods of quickly and easily measuring soil moisture. The results of these experiments have, from time to time, been described in scientific publications and bulletins. A review of the literature on the subject reveals a number of methods of moisture measurement of which nearly all fall into one of the following categories:

1. Gravimetric—

   (a) Determination of moisture in soil samples by comparison of weight of sample to its dry weight.

   (b) Determination of moisture in porous media in moisture equilibrium with the soil, by comparison of weight to dry weight.

2. Electrothermal — Determination of moisture in soil by measurement of heat conductivity of the soil or porous media in moisture equilibrium with the soil.

3. Tensiometer — Determination of moisture in soil by measurement of the equilibrium tension of water in a porous container in contact with the soil.

4. Electrical — Determination of moisture by measurement of electrical properties of (a) soil and (b) porous media imbedded in the soil.

For the past 2 1/2years, I have been observing a series of tests under field conditions, to determine the value of some of these methods of measuring soil moisture, the last named technique being most thoroughly investigated. The steps taken in these tests and the results obtained will be of interest to many growers who are engaged in scientific agriculture. The apparatus used was a special adaptation of the wheatstone bridge and specially designed sorption units used to measure electrical resistance. The sorption units consist of a pair of electrodes imbedded in gypsum to which have been added metallic oxides. These sorption units are 1 1/8 inches in diameter and 2 3/8, inches long.

Installation: The sorption units are imbedded in the soil to a depth at which readings are desired. Wire cords are extended to a point above the surface of the ground. After a lapse of 24 hours the sorption units are in moisture balance with the surrounding soil. That is, they are no longer gaining or losing moisture. By attaching the wire leads to the moisture meter, an electric current flows through the cords and passes through the gypsum wall that separates the two electrodes within the sorption unit. The electrical resistance of this wall is thereby measured. This resistance varies with the amount of moisture present in the unit, being extremely high when the sorption unit is dry, and low when wet.

When electrodes are uniform in shape and size and when exactly spaced within the unit, measurement of electrical resistance enables the operator to determine the amount of moisture in the unit and, therefore, in the surrounding soil.

It has been found that the sorption units lose or gain moisture from the surrounding soil. The electrical resistance is a remarkably accurate index of the soil moisture.

Sorption units were installed at various depths in several separate soil types. Changes in electrical resistance were followed through cycles of wet to dry. At each meter reading, soil samples were taken by use of a soil sampling tube, care being exercised that the sample was from the same level and in close proximity to the sorption units. Comparison between the oven dry method and meter readings revealed a remarkable degree of conformity between the two techniques.

During the period covered by these studies, the manufacturer of the moisture meter perfected and is marketing this new instrument which is calibrated in per cent of the available moisture range. With this, the grower may determine what percentage of moisture in this range still remains in the soil. With the necessary information of "wilt point" and "field capacity" accurate knowledge of moisture conditions expressed in per cent of dry weight, acre inches, gallons per acre foot, or any other method of expressing soil moisture, is readily determined.

Due to the fact that the moisture meter reads in terms of per cent of the "available moisture range," the user must know the limits of that range in order to transpose meter readings into terms of per cent of dry weight, acre inches of water, or any other orthodox method of expressing moisture in soils. When "wilt point" and moisture equivalent are known it is a simple matter to determine from the meter readings the amount of water which would be required to bring the soil up to "field capacity."

The following simple formula may be used for transposing meter readings into terms of actual moisture, as expressed in percentage of dry weight.

"Field Capacity" minus "Wilt Point" multiplied by Meter Reading.

Since "field capacity" and "moisture equivalent" are quite different factors at both extremes of soil textures, special tables must be developed when sorption units are used on the very "heavy" or very "light" soils.

Moisture determination, as accomplished by the oven dry method, involves the use of considerable equipment and man hours of labor. This has contributed to widespread neglect of maintaining continuous knowledge of soil moisture conditions, particularly with respect to rate of moisture loss and predetermination of irrigation activities.

By the use of a moisture meter and sorption units, frequent readings can be made and a continuous record of moisture conditions maintained.

Several sorption units per acre are advisable and practical.