

Neutrons in Water-use Studies

portable neutron equipment permits repeated measurement of soil moisture without injury to plants or disturbing soil

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Accuracies of soil moisture measurements obtained with recently developed neutron equipment are comparable to those associated with conventional sampling procedures.

The new equipment offers the possibility of eliminating many of the problems usually encountered in studies on the use of water by plants. Ordinarily, such studies are conducted by growing plants in containers and weighing the system periodically to measure water loss.

The difficulty of weighing large containers of soil, the time and labor required to sample a soil volume periodically, and the problem of calibrating soil moisture units are some of the disadvantages of the water measuring methods.

The development of portable equipment has now made available a neutron method of soil moisture measurement.

In an experiment with portable neutron

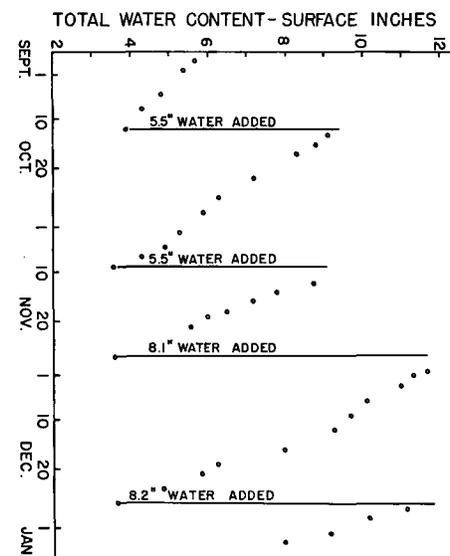
equipment, 36" concrete drain tiles were used to contain soil columns from 30" to 42" deep. An aluminum access tube was centrally located in each soil column. The tubes extended from 2½" above the soil surface to the bottom of the column. The tubes provided mechanical support for the neutron equipment and an opening through which to lower a moisture probe into the soil.

Direct Measure

The moisture probe contains a source of fast neutrons located near a slow neutron detector. The fast neutrons are slowed down upon collision with hydrogen atoms in soil water, and the slow neutrons that return to the detector are counted. The number of slow neutrons detected per unit time is a direct measure of soil moisture. A rate meter, rather than a counting unit—with a previously established relationship between the volume moisture percentage of the soil and the rate meter readings—was used in the experiment.

Three tomato plants per soil column were grown for a five-month period. During this time rate meter readings were recorded before each irrigation and from one to four days after a measured quantity of water was added to a column.

Total water content calculated from neutron measurements for sandy loam in a cylinder 36" in diameter and 42" deep.



Additional readings were taken between irrigation dates.

The total water content of a soil column—expressed as surface-inches—was recorded at the time meter readings were made. The rate meter readings were converted to percent moisture by volume—Pv—and plotted on graph paper.

Water Content Calculated

To conclude the experimental work, soil cores at 2.4" in diameter and 3" in length were taken at six locations around the access tubes. From 80 cores, the water content of one of the typical soil columns was calculated to be 7.7 plus-or-minus 0.4 surface-inches. The water content of the column was calculated to be 7.6 surface-inches from meter readings. The computed values of the total water content of the other columns were within the ranges of surface depth values that were determined from core samples.

Calculated values for the surface depth of water in a sandy loam of one of the columns are shown in the accompanying graph. Average water-use rates for the drying cycles were 0.20, 0.26, 0.34, 0.33, and 0.53" per day. The rates increased with plant size during the five-month period of plant growth in spite of weather changes from September to December. The water-use values do not apply to field conditions because of the larger plant population in the column as compared to that under normal field practices. The soil suction did not exceed one bar during this period.

Field Use

The measurements obtained in the study indicate that the neutron method of moisture measurement may be useful in field studies of the storage of water in the soil and of the rate of the depletion of water from the soil by plant roots.

In conducting water-use studies or irrigation efficiency studies involving deep-rooted crops the neutron method can provide information additional to that obtained by conventional soil sampling procedures.

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Portable neutron equipment mounted on wheels for mobility in orchards.

