Maximizing the use of soil moisture sensors

By Davie Kadyampakeni, Ajia Paolillo and Sandra Guzmán

Citrus trees require water to be able to carry out the natural processes of growth, making food, and developing fruit and juice. To get the water from the soil, the fibrous roots do the extraneous work of absorbing the water and carrying it via the transpiration stream (or the water highway) to the leaves. The water in the soil is made available through either irrigation or rainfall.

This article focuses on how to use soil moisture sensors to determine how much water to apply and how to use sensors for irrigation management.

SENSOR TYPES

Improved irrigation-scheduling techniques that use soil moisture sensors to control irrigation events can greatly increase water-use efficiency. There are several types of soil moisture sensors that are commercially available.

Soil moisture sensors are classified into two categories (volumetric or tensiometric) based on how they measure soil moisture. Volumetric soil moisture sensors provide soil moisture as volume of water per volume of soil, while the tensiometric sensors give water content as a unit of suction or water potential.

There are at least seven different operating principles used by various brands of electronic soil water sensors: time domain reflectometry (TDR), time domain transmission (TDT), frequency domain reflectometry, amplitude domain reflectometry, phase transmission, tensiometer and resistance granular matrix sensors. The suitability of each sensor depends on the cost, accuracy, response time, installation, need for calibration, management, maintenance, durability and soil type.

For Florida sandy soils, sensors that require minimal soil disturbance are preferred. TDR and TDT sensors are more ideal due to low maintenance requirements, high degree of accuracy and low need for calibration.

Sensors are typically operated by battery power, and some also utilize solar panels. When deciding on a location, be sure to find an area with adequate light coverage if using solar-operated sensors.

Some sensors may have a built-in rain gauge. This is beneficial to determine amounts of rainfall in a particular area and if the precipitation is causing the change in soil moisture, especially if you do not have a weather station in close proximity to your grove.

Sensors are available through several manufacturers, and each company has unique formats for displaying the data derived from the sensors. Thus, when looking at the data, your "dashboard" for each company will be slightly different. Graphs can be displayed in various formats. In many cases, the user can select which data to view, allowing for the comparison of data from one sensor or multiple sensors.

INSTALLATION TIPS

When installing sensors in the root zone, it is important to place them within a 1- to 1.5-foot radius of the irrigated zone to make sure the sensor is reporting accurate information. When the sensor is installed outside the irrigated zone, one can overestimate the need for irrigation by assuming that soil moisture is low and needs to be replenished. For proper irrigation planning, it is always good to install sensors in the active root zone, which is typically within the top 12-inch soil depth.

To ensure nutrients are not being leached beyond the root zone, it is highly important to install one or more sensors at 18- or 20-inch depths or deeper to show any changes in soil moisture. Elevated soil moisture below 18 inches suggests

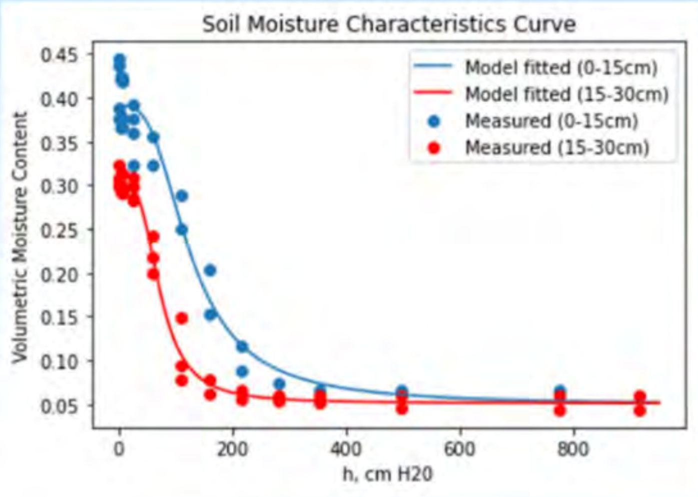

Figure 1. Soil moisture characteristics curve at varying suction at 0- to 6-inch (0 to 15 centimeter) and 6- to 12-inch (15 to 30 centimeter) soil depth on Florida Ridge sandy soil.

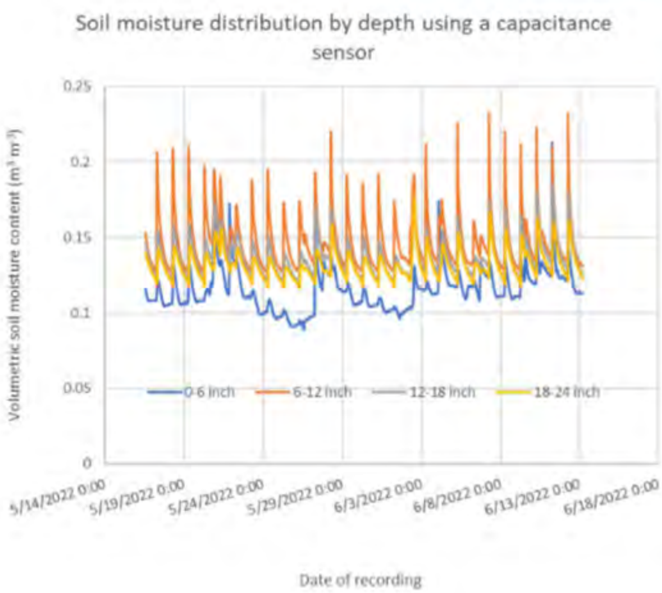

Figure 2. Soil moisture distribution every hour at 0 to 6, 6 to 12, 12 to 18 and 18 to 24 inches.

increased potential for nutrient leaching and thus the need to optimize the irrigation rate. It is preferred to install the sensors after a rain event or in a well-watered soil to reduce the influence of air gaps. Check the graphical trends over a week to assess where the soil is at the maximum saturation point (see https://edis.ifas.ufl.edu/publication/AE551).

READING THE DATA

Soil moisture data provides an indirect measurement of the water that a soil can hold. For sandy soils, the soil water-holding capacity is represented by a small range (based on the soil moisture characteristic curve that relates volumetric soil moisture and soil matric potential, Figure 1) that indicates a need for frequent short-time irrigations.

The volumetric sensor provides soil moisture as volume of water per volume of soil recorded across time (Figure 2). If the data provided is in bars or other energy units, the user might be dealing with tensiometric sensors. These sensors provide soil moisture as suction or matric potential due to capillarity.

TROUBLE SHOOTING

Sometimes sensors fail in the field as a result of poor connection, wild animals or damage from herbicides or spray equipment. Thus, it is a good idea to keep an eye on sensors from time to time to make sure the information is being provided in a timely fashion.

If a cable is damaged, order a replacement cable from the sensor provider. If a data logger is wet due to heavy rain, repair the unit and secure it carefully when installed. Marking the ends of the rows where sensors are located can serve as a visual reminder for equipment operators to use caution.

SUMMARY

Using soil moisture sensors can aid in decision making regarding irrigation management. Sensors that are easy to calibrate or need no calibration, are easy to maintain, and can be used for irrigation and fertigation management on Florida sandy soils are preferred. These tools will help growers judiciously use their water resources.

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