MONITORING SOIL WATER STATUS IN ORCHARD CROPS

Soil moisture monitoring can be used alone or in combination with midday stem water potential or estimates of crop water use to assist water management. There are dozens of different soil moisture monitoring devices available commercially to evaluate the soil-water conditions in a walnut orchard or any other crop. In general, there are two broad categories of tools or devices: 1) tools that detect and indicate soil-water content; and 2) devices that detect and indicate soil matric potential, that is, the degree of tension that soil-water is held by the soil and available for uptake by the crop.

Soil Moisture

Figure 1 shows three tools for evaluating soil water content. A post-hole digger (Figure 1a), a soil auger, or a shovel can be used to excavate soil and the soil-water content can be evaluated subjectively by how it handles and feels and by its appearance. Alternatively, volumetric soil-water content can be precisely measured with a neutron probe (Figure 1b) or a capacitance probe (Figure 1c). The neutron probe is a radioactive device that has been used to monitored soil-water content for several decades. Due to its radioactivity, the device must be operated by a licensed operator and, therefore, is most often available through professional agricultural consultants. Capacitance probes represent newer technology than the neutron probe and have been used for water management in agricultural for over a decade. Capacitance probes are not radioactive but are technically advanced and usually supported by a professional agricultural consultant.

Figure 1. Three tools for monitoring soil-water content: a) post-hole digger to excavate soil and evaluate soil-water content by feel and appearance; b) neutron probe; and c) capacitance probe.

Soil Tension

Figure 2 shows soil moisture resistance blocks that are used to measure soil matric potential, the tension that water is held by the soil and affecting its availability to the crop. One of the more commonly used resistance blocks is marketed under the trade name "WaterMark".

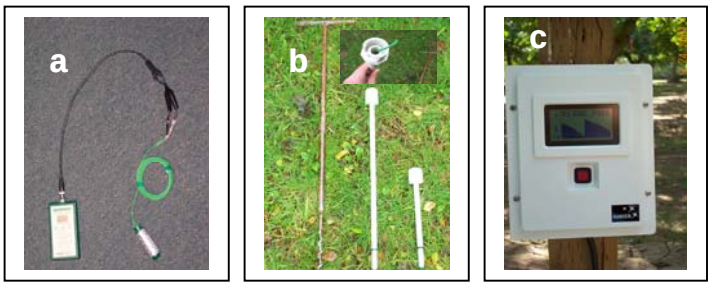

Figure 2. Illustration of soil moisture resistance blocks used to measure soil matric potential: a) resistant block connected to a manually operated resistance meter; b) resistance blocks that have been fitted into ½ inch PVC pipe for portable installation and removal; and c) a battery powered datalogger that can be connected to the resistance blocks to record soil matric potential on daily frequencies and store the date for several months.

Monitoring soil-water content or soil matric potential can be done at multiple depths throughout a soil profile and crop rootzone. Soil moisture monitoring is especially useful: 1) to understand the water holding capacity of specific soils; 2) to determine how deep water percolates into the soil profile after rainfall or irrigation; 3) to understand the distribution of the crop root zone and depth of soil that the

crop extracts water; and 4) to determine seasonal water extraction trends in the root zone. Capacitance probes and resistance blocks can be fully automated using telemetry or battery or solar powered dataloggers. Automation saves labor and assures timely and routine monitoring of soil moisture conditions.

Soil Variability

A challenge associated with soil moisture monitoring in orchards is locating the sensors in representative locations. Non-bearing orchards with developing root systems, variable soils where pre-plant slip plowing is sometimes employed, and drip and micro sprinkler systems that irrigate only a portion of the orchard floor and have variability in the aerial distribution of the irrigation water are some potential influences on whether soil moisture monitoring is representative.

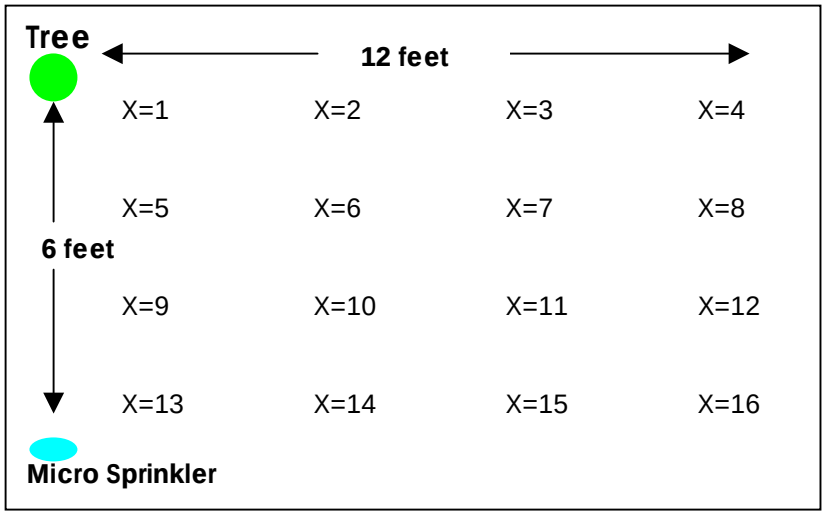

Figure 3. Schematic of a grid of sixteen neutron probe access tubes installed in a 72 square foot area and used to measure soil water content. Grid duplicated for two trees.

Figure 3 shows a soil moisture measurement grid that was used to monitor soil moisture in a relative small area around individual almond trees. The area represented one quadrant of the space around a single almond tree in an orchard and consisted of 72 square feet. On the same day, soil water content was measured in one-foot increments to a depth of 54 inches in each of the access holes and summed to determine the soil-water content in the entire five-foot soil profile. The measurements were duplicated for two trees, each irrigated according to different management goals.

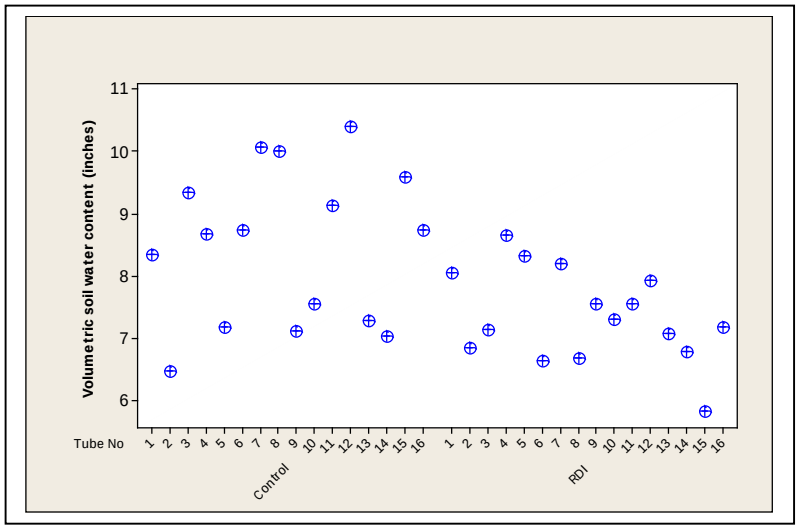

Figure 4. Volumetric soil-water content (inches per five-foot profile) determined on the same day using a calibrated neutron probe and a grid of sixteen access tubes located in one quadrant of two different almond trees under different irrigation regimes.

Figure 4 presents the total soil-water content in the 54 inch soil profile measured on the same day for two almond trees where densely configured soil moisture monitoring grids were used. In the "control" irrigation regime, the total soil water content ranged from 6.5 inches to 10.5 inches, representing a variation of 4.0 inches of water

or 50 percent variation from the average soil-water content in the profile depending on where the soil water content was measured in the relative small area around the almond tree. In the "RDI" regime, the variation in soil moisture content ranged from 5.8 to 8.5 inches, a difference of 2.7 inches of water in the soil profile or a variation of 40 percent from the average depending on where soil moisture was measured in the quadrant.

Some Sources of Soil Moisture Monitoring Equipment

Note: This is a partial list and endorsements of specific products and suppliers are not intended by listing these providers of soil moisture monitoring tools. There are numerous manufactures, distributors, and retail suppliers.

Soil augers and related field sampling equipment:

AMS, Inc.
105 Harrison Street
83211 American Falls,
ID, USA
Phone: 208-226-2017 / 800-635-7330
Fax: 208-226-7280
http://www.ams-samplers.com

Soil Moisture Monitoring Tools and Automation:

Capacitance Probes and Telemetry

1. IRRIGATE.NET
   1770 Serenity Way
   Chico, CA 95928
   Phone: 530-893-4520
   Fax: 530-893-1342
   http://www.irrigate.net

2. AdCon Telemetry
   2050 Lyndell Terrace, Suite 120
   Davis, CA 95616
   (530)-753-1458
   http://www.sowacs.com

3. AgriLink
   2282 Airport Boulevard
   Santa Rosa CA 95403
   Phone: (707)-522-2274
   Fax: (707)-579-1735
   http://www.agrilink.net

Resistance Blocks, Dataloggers, and Telemetry

1. Irrometer Company
   P.O. Box 2424
   Riverside, CA 92516
   Phone: (951)-689-1701
   Fax: (951)-689-3706
   http://www.irrometer.com

2. Soil Moisture Equipment Corp.
   801 S. Kellog Ave.
   Goleta, CA 93117
   Phone: (805)-964-3525
   Fax: (805)-683-2189
   http://www.soilmoisture.com

3. Spectrum Technologies Inc.
   12360 South Industrial Drive
   East-Plainfield, Illinoise 60585
   Phone: (800) 248-8873 / (815) 436-4440
   Fax: (815) 436-4460
   http://www.specmeters.com

4. M. K. Hansen Company
   2216 Fancher Blvd.
   East Wanatchee, WA 98802
   Phone: (509)-884-1396
   Fax: (509)-884-3318
   http://www.mkhansen.com