Irrigation Scheduling Tools – Selection & Operation

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Equipment Selection

Soil Considerations

Many good soil moisture sensors are on the market. Selection of the best sensor for your purposes depends on the amount and type of information you desire. At the most basic level, the device should give a repeatable index of soil moisture content (either soil moisture as percent by volume or matric potential (as in tensiometers or granular matrix sensors).

If you work with a soil that shrinks as it dries, or with a low water holding sandy soil, devices that require good contact with the soil may not give good, repeatable readings after the soil has passed through one drying cycle. Devices with the contact area shaped as a flat plate are particularly prone to breaking contact on shrink – swelling soils, particularly if a crack forms through the installation area.

Devices that require direct soil contact and free interchange of soil water with the sensor (tensiometers and watermarks, etc.) may have problems on very sandy soils. Watermarks require the movement of soil water into the sensor to equilibrate the matric potential of soil to that in the sensor. In very sandy soils, except near saturation, the minimal pore water present does not move readily so measurements may be in error. Because water flows out through the ceramic cup of a tensiometer to the soil as it dries, tensiometers can maintain better soil contact and function better in very sandy soils than watermarks.

Data Requirement Considerations If an

Watermark Moisture Sensor: These sensors relate an electrical resistance measurement to soil moisture. Soil moisture tension in centibars (how hard the plant has to work to get water out of the soil) is the measurement provided by the meter. Reading repeatability is good to within + 3 centibars. Each unit costs

Portable TDR: This device uses a 2 or 3-prong sensor about 12 inches long that is inserted into the soil to full length. It sends a high-frequency pulse and measures the time required to sense the reflected signal. This method determines the dielectric constant of the moist soil. From this the moisture content of the soil can be accurately and repeatably determined. To use this method, readings should be taken daily and the threshold number for irrigation determined from the pattern of the readings, the irrigator's experience, and perhaps another method. Once the threshold is determined, readings at several day intervals are sufficient to determine when the soil is nearing the threshold and needs irrigation. Cost is about $800.

Aquaflex: This instrument, developed in New Zealand, uses technology similar to the TDR instrument to determine volumetric soil moisture content. The sensors are about 10 feet long and are buried horizontally at the desired depth. This length takes some of the variability out of the readings. It can be programmed to collect data from up to four sensors at one of a variety of time intervals. It provides a nearly constant record of soil moisture variation. Irrigator experience, along with the instrument readings must be used to establish an irrigation threshold. Once established, it can be used for irrigation scheduling and forecasting quite effectively. Data can be downloaded at any desired interval onto a palmtop or laptop computer for plotting and analysis. Cost is about $1,800-$2,500 depending on cables and sensors required.

Enviroscan: This instrument, developed in Australia, uses technology similar to the TDR instrument discussed above to determine volumetric soil moisture content. The data logger can accommodate up to 32 sensors distributed among up to 8 sites (e.g., 4 depths at each of 8 sites, and can be solar-powered. Data are downloaded to another computer for analysis. The sensor is installed in a PVC access tube placed in the soil with cables connected to the data logger unit. This site has sensors at 10, 20, 30, 50 and 60 cm depths (15 c = 6 inches). This unit provides a nearly continuous record of soil moisture variation which can be used to determine depth of rooting and if leaching from any soil layer occurred on a daily basis. Irrigator experience, along with instrument readings, must be used to establish an irrigation threshold condition. Once established, it can be used for irrigation scheduling and forecasting quite effectively. Costs range from about $4,000 for a 2-probe, 8-sensor unit to serve one center-pivot to about $6,000 for a 4-probe, 16sensor unit that can serve two adjacent pivots or other irrigation systems.

Installation, Placement and Data Interpretation

Sensor Installation

Installation of all sensors causes the soil immediately around the sensor to be disturbed. The challenge is to excavate and install the sensor in a manner to assure good soil contact without changing compaction level or other soil properties relative to the field you wish to describe with the sensor. The most common problem with sensors is improper installation, usually resulting in poor soil-sensor contact. If a circular sensor is installed by insertion into a hole slightly larger than the sensor, soil must be added and worked around the sensor to assu good contact. An alternative is to add thick soil slurry to fill the hole several inches deep before inserting the sensor. Adding a soil slurry works well on all but soils that shrink as they dry. For these soils, a better alternative is either to make the hole with a probe slightly smaller than the sensor diameter, or to use a bucker auger to make a hole 2-3 times the sensor diameter and plant the sensor like a fence post (being care not to over-compact the soil).

Sensor Placement

Sensors should be installed between plants in the row. Typically water applied by sprinkler irrigation is diverted by crop leaves so that more falls between rows than in the row area. As a result, the row or hill area will usually be drier than the soil between rows. Particularly with potatoes, the majority of the water used by the plant comes from the hill area, so it is the area to monitor. Ideally, sensors should be placed at a minimum of three depths in the hill area. In potatoes, one should be at about seed piece depth (the depth of most water uptake), another at about 16 inches (to monitor adequacy of additional water that can be extracted when

Table 1. Relationship between watermark or tensiometer readings and percent available soil water for a sandy loam soil.

Sandy Loam (1.67 in/ft):

Percent Available Soil Water	Water-mark Reading cbars	Inches to refill 1 ft of soil pivot or linear	Inches to refill 1 ft of soil hand or wheel line
100	10	0	0
85	12	0.32	0.36
80	14	0.42	0.48
75	16	0.52	0.6
70	18	0.63	0.72
65	20	0.73	0.84
60	24	0.84	0.95
55	27	0.94	1.07
50	30	1.04	1.19
40	43	1.25	1.43
30	71	1.46	1.67
Percent Available Soil Water	Water-mark Reading cbars	Inches to refill 1 ft of soil pivot or linear	Inches to refill 1 ft of soil hand or wheel line

Sandy Loam (1.67 in/ft):
(Potatoes, Mint, Onions, Dry Beans)
0 Saturated soil
0-10 Leaching Possible
10-24 Best Crop Growth
>24 Crop Water Stress

Sandy Loam (1.67 in/ft):
(Alfalfa, Beets, Grain, Corn, Pasture)
0 saturated soil
0-10 Leaching Possible
10-30 Best Crop Growth
>30 Crop Water Stress

Table 2. Relationship between watermark or tensiometer readings and percent available soil water for a Light-Textured Silt Loam soil.

Light-Textured Silt Loam (1.97 in/ft):

Percent Available Soil Water	Water-mark Reading cbars	Inches to refill 1 ft of soil pivot or linear	Inches to refill 1 ft of soil hand or wheel line
100	10	0	0
85	12	0.32	0.36
80	14	0.42	0.48
75	16	0.52	0.6
70	18	0.63	0.72
65	20	0.73	0.84
60	24	0.84	0.95
55	27	0.94	1.07
50	30	1.04	1.19
40	43	1.25	1.43
30	71	1.46	1.67
Percent Available Soil Water	Water-mark Reading cbars	Inches to refill 1 ft of soil pivot or linear	Inches to refill 1 ft of soil hand or wheel line

Light-Textured Silt Loam (1.97 in/ft):
(Potatoes, Mint, Onions, Dry Beans)
0 Saturated soil
0-10 Leaching Possible
10-25 Best Crop Growth
>25 Crop Water Stress

Light-Textured Silt Loam (1.97 in/ft):
(Alfalfa, Beets, Grain, Corn, Pasture)
0 Saturated soil
0-10 Leaching Possible
10-40 Best Crop Growth
>40 Crop Water Stress

Table 3. Relationship between watermark or tensiometer readings and percent available soil water for a