Irrigation Scheduling Techniques Used in Field Plots

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Six irrigation scheduling tools are being demonstrated and evaluated at two sites in Southern Idaho. This is the first year of the three-year study. One site, near Eden, is a sandy loam soil with potatoes as the crop. The other site, near Minidoka, is a silt loam soil, also with potatoes. At each site the six treatments are replicated four times in a random design. Plot size is 12 x 50 feet.

<u>Watermark Moisture Sensor:</u> 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 about $15-$18, depending upon lead length, and the meter about $200. The sensor is composed of an electrical resistance element surrounded by a gypsum block to minimize salinity effects. The sensor/block is then surrounded by sand of a specified diameter to provide the repeatable porous medium in which the sensor functions. Sensor range is zero (saturation) to 200 centibars (drier than irrigation should begin on any crop).

The sensors are soaked in water for 48 hours to saturate the resistance element and then installed in a near-saturated soil at the desired depth. Good contact between the sensor and soil is essential for water content in the sensor to equilibrate with that in the soil. Guidelines for sensor placement and threshold values at which to begin irrigation on a variety of crops and soils have been developed.

<u>Tensiometers:</u> These sensors use a porous ceramic cup attached to the bottom of a clear plastic tube/water reservoir and calibrated vacuum gage to measure soil moisture tension in centibars. Tensiometers come in varying lengths, from 1 foot to 4 feet in length, with cost ranging from $45 to 60 each, depending on length. These devices are also soaked in water for at least one day before installation. Good contact between the ceramic cup and the surrounding soil is also essential for this device. As water flows out of the tensiometer into the surrounding soil until moisture equilibrates, it creates a partial vacuum in the tensiometer body which is read on the calibrated vacuum gage as matric potential or soil moisture tension. Guidelines for sensor placement and threshold values at which to begin irrigation on a variety of crops and soils have been developed. This device responds more quickly to changes in soil moisture than does the watermark sensor, but operating range is only from zero to about 70 centibars. This is sufficient for potatoes, but may be a little restrictive for grain, alfalfa, and beets on silt loam and heavier soils.

<u>Aquateer:</u> This device measures capacitance changes in soil and relates these changes to soil moisture content. It is portable and allows the user to take any number of measurements at any location and depth. Cost is about $350. Measurement depth is limited by the ability to push the probe into the soil, however. Its output is in percent saturation, or the percent of soil pore space filled with water. Percent saturation can be experimentally related to soil moisture tension and to percent soil moisture by volume. The threshold reading that indicates that irrigation should begin has been somewhat developed for a variety of crops and soils. With individual irrigator experience, the threshold value for particular crops and soils can be well developed. Reading repeatability is good.

<u>AGRIMET Checkbook/Feel and Appearance:</u> This method, also known as the "checkbook" method, uses soil and crop properties to determine how much water can be extracted by the crop between irrigations without moisture stress. Daily ET (crop water use and evaporation from soil) is calculated

based on local climate data. A number of weather stations in southern Idaho are linked to the US Bureau of Reclamation AGRIMET system in Boise by satellite. Calculations are made for each station for each crop grown in the area at 15-minute intervals. This information is available at any time by computer and dialup modem or on the Internet at www.pn.usbr.gov\agrimet. It is also published in a number of southern Idaho newspapers.

In operation, the water that can be extracted between irrigations is determined, and then daily ET subtracted from that "balance". When the "balance" nears zero, irrigation should begin. Sufficient water is added back to refill the soil in the crop root zone and the process begins again. The timing of irrigation is usually checked with the "feel and appearance method" of determining available soil moisture to make sure that calculations match reality. The cost for this method is minimal and it can perform very well. It does take some time to update for each field each day, but new computerized delivery methods are being developed.

Portable TDR: This device uses a 2-prong sensor about 12 inches long that is inserted into the soil to full length. It sends a high-frequency pulse down both prongs 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, then 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. We are currently using hourly soil moisture data collection. 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. In our arrangement, the data are downloaded at any desired interval onto a palmtop computer and transferred to our office computer for plotting and analysis. Cost is about $1,800-$2,500 depending on cables and sensors required.

Enviroscan (Minidoka Site): 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 sensors are 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 cm = 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. In our arrangement, data are downloaded weekly by Sheldon Sorenson with Simplot in Rupert, and faxed to us along with recommendations on how to modify our current irrigation schedule. 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, 16-sensor unit that can serve two adjacent pivots or other irrigation systems.

For more information on any of these devices, please contact Howard Neibling at the University of

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