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Irrigation: Don't Wait --- Irrigate

Cooperative Extension South Dakota State University

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IRRIGATION

Don't Wait--
Irrigate

COOPERATIVE EXTENSION SERVICE
SOUTH DAKOTA STATE UNIVERSITY
U. S. DEPARTMENT OF AGRICULTURE
"When should I irrigate?" is a question confronting every irrigator. Even though a well-designed system will be capable of supplying the water needs of a crop on a given soil type, irrigation must start before a soil moisture deficiency develops. If irrigation does not begin before a plant moisture stress exists across the whole field, the last area of the field to be irrigated could suffer from a moisture deficiency since it takes several days to irrigate most fields.

"Available" moisture is that part of the "total" moisture which is available to the plant. The amount of available moisture present in the soil at any time depends on the type and depth of soil, rate of transpiration, rate of evaporation, and the depth of application and period of time since the last irrigation or rainfall.

There is no substitute for experience in estimating soil moisture levels; however, standardization of procedures and the aid of available instruments can be employed to assist the irrigator in correctly evaluating the available moisture in his soil.

The "feel" method, and the use of tensiometers or electrical resistance blocks are the most common field methods for determining available soil moisture. None of these measure the effects of salts on the availability of moisture. Other moisture measuring instruments are presently being tested and evaluated.

<table>
<thead>
<tr>
<th>Percent useful soil moisture remaining</th>
<th>Light (loamy sands and sandy loams)</th>
<th>Medium (very fine sandy loams and silt loams)</th>
<th>Heavy (silty clay loams and clay loams)</th>
</tr>
</thead>
<tbody>
<tr>
<td>10 or less</td>
<td>Dry, loose, flows through fingers</td>
<td>Powdery, dry, sometimes slightly crusted but easily breaks down into powdery condition</td>
<td>Hard, baked, cracked, sometimes has loose crumbs on surface</td>
</tr>
<tr>
<td>50 or less</td>
<td>Still appears to be dry; will not form a ball*</td>
<td>Somewhat crumbly but will hold together from pressure</td>
<td>Somewhat pliable, will ball under pressure*</td>
</tr>
<tr>
<td>50 to 75</td>
<td>Tends to ball* under pressure but seldom will hold together</td>
<td>Forms a ball* somewhat plastic; will sometimes slick slightly with pressure</td>
<td>Forms a ball* will ribbon out between thumb and forefinger</td>
</tr>
<tr>
<td>75 to field capacity</td>
<td>Forms weak ball,* breaks easily, will not slick</td>
<td>Forms a ball* and is very pliable; slicks readily if relatively high in clay</td>
<td>Easily ribbons out between fingers; has a slick feeling</td>
</tr>
<tr>
<td>At field capacity</td>
<td>Upon squeezing no free water appears on soil but wet outline of ball* is left on hand</td>
<td>Same as light</td>
<td>Same as light</td>
</tr>
</tbody>
</table>

*Ball is formed by squeezing a handful of soil very firmly with fingers (about the squeeze required for a hardy handshake).
A tensiometer consists of a sealed, water-filled tube with a porous ceramic tip on the lower end and a vacuum gauge on the upper end (Figure 2).

The tensiometer gauge (Figure 3) indicates soil moisture tension or soil suction. It does not indicate moisture percentage. This suction, generated as moisture is removed from the soil by the crop, draws water from the tensiometer tube through the porous tip causing the vacuum created to be registered on the gauge. The drier the soil the higher the vacuum.
INSTALLATION AND USE

Tensiometer control of irrigation is based on “stations” set up to give a good indication of the available moisture throughout a specific field. A “station” should consist of two tensiometers of different lengths (see Table 2) installed in the same proximity, usually in the crop row. Each station should fully evaluate the active root zone of the crop (Figure 1). The shallow tensiometer will be used to evaluate the surface moisture conditions and will determine when irrigation should begin. The deeper tensiometer will evaluate penetration. This deeper tensiometer should be used for controlling irrigation in a situation where several small rains are sufficient to keep the top foot of soil adequately watered but when dry conditions could exist in the lower part of the profile.

Table 2. Recommended Depths of Setting Tensiometers

<table>
<thead>
<tr>
<th>Soil depth or active root zone (inches)</th>
<th>Shallow tensiometer (inches)</th>
<th>Deep tensiometer (inches)</th>
</tr>
</thead>
<tbody>
<tr>
<td>18</td>
<td>8</td>
<td>12</td>
</tr>
<tr>
<td>24</td>
<td>12</td>
<td>18</td>
</tr>
<tr>
<td>36</td>
<td>12</td>
<td>24</td>
</tr>
<tr>
<td>48 or more</td>
<td>18</td>
<td>36</td>
</tr>
</tbody>
</table>

Station locations should be selected which represent the average field conditions of soil type, slope and plant population. Do not place tensiometer in high or low spots in the field. Locate stations according to the following general guidelines:

Gravity Irrigation (for furrows or borders). Place two stations in the first set with a station about 50 feet from each end of the run (Figure 4) in the same crop row. Place two more stations in the last irrigation set. Do not dike the ends of the furrows.

Sprinkler Irrigation (for tow-line, side move, or big gun systems). Locate stations parallel to the mainline and about 50 feet into the crop (near the mainline or at the far end, whichever is more accessible). Select the area covered by one lateral in the first and last set in the field.

Sprinkler Irrigation (for center pivot systems). Locate the stations about one-third of the distance from the center on each quarter of the circle.

Stations in the first and last sets will help to determine when to start irrigating again should a rain disrupt the irrigation schedule.

When installing and using tensiometers, keep the following suggestions in mind:

1. Prepare tensiometer for installation with respect to specific manufacturer’s instructions. This involves filling the instrument with solution and removing air from the gauge and the pores of the ceramic tip.
2. Install tensiometers in the field as soon after planting as possible. Place a flag or tall marker at each station for easy location throughout the growing season.
3. Prepare a hole with soil probe the same size as the tensiometer tube. For row crops, place the tensiometer in the row and angle it toward the furrow. Place the shallow tensiometer tip under the edge of the furrow and the deep tip under the furrow (Figure 5). A good contact between the buried portion of the tensiometer and the soil is essential to obtain accurate records. If air or water is permitted to follow down the plastic tube, incorrect readings will occur. To provide good surface drainage, bank some soil around the tube and pack to insure good tensiometer to soil contact.
4. Keep the soil around the tensiometer stations as representative of the field as possible by always approaching the station from a row other than the one in which that station is located. This will avoid compaction in the vicinity of the tensiometer.

5. Carefully remove the tensiometers from the field after the irrigation season has been completed or prior to freezing. Whichever occurs first.

The frequency of reading the tensiometers depends on the soil type, stage of crop growth, and the weather, but daily readings are recommended. The minimum should be three times a week. Plotting the tensiometer readings on a chart as shown in Figure 6 (particularly those before and after rain or irrigation) is very helpful in evaluating the moisture holding capacity of your soil and the effectiveness of irrigation. The timing of future irrigations may be approximated by extending or projecting the curve as it moves upward.

Service the tensiometers in the field in accordance with the manufacturer’s recommendations. In the process of removing water from the tensiometer when the soil is dry and adding water when the soil moisture content increases, air is drawn up in the tensiometer tube and collects at the top. Displace this air periodically by adding water to assure good instrument response to soil moisture changes.

**INTERPRETATION OF TENSIOMETER READINGS**

Tensiometers measure the availability rather than quantity of soil moisture; however, the operator’s experience on his specific soil and area is very important in interpreting tensiometer readings. Table 3 gives some general rules for interpreting tensiometer readings.

**START IRRIGATION**

Use the shallow tensiometer to indicate the time to start irrigation. In some cases it may be beneficial to set the shallow tensiometer somewhat shallower than is indicated in Table 2 for the first portion of the growing season. Only after fall or early spring irrigation or when salt leaching is required should water penetrate below the active root zone. For early irrigations, water penetration should not reach the deep tensiometer. For mid-season and late-season irrigation, the deep tensiometer should show a response.

Depth of penetration in other areas of the field may be evaluated by using a soil probe, or a steel rod (can be pushed into ground until dry soil is encountered).

**ELECTRICAL RESISTANCE BLOCKS**

The electrical resistance block method (see Figure 7) uses a portable resistance meter and small blocks which are made of fiberglass, nylon or gypsum surrounding a pair of stainless steel wires or wire grids
Table 3. Interpretation of Tensiometer Readings

<table>
<thead>
<tr>
<th>Condition of Soil</th>
<th>Percent of dial reading or centibars</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Saturated</td>
<td>0</td>
<td>Saturated soil often occurs for a day or two following irrigation. Danger of waterlogged soils, poor root aeration or high water table if readings persist.</td>
</tr>
<tr>
<td>Wet</td>
<td>10</td>
<td>Field capacity. Irrigation discontinued in this range to prevent waste by deep percolation and leaching of nutrients below the root zone. Light soils will be at field capacity in the lower range (10-15) with heavy soils at field capacity in the upper range (15-20).</td>
</tr>
<tr>
<td>Irrigation range</td>
<td>30-40</td>
<td>Usual range for starting irrigations. Root aeration is assured in this range. In general, irrigations start at a reading of 30-40 on coarse-textured soils (loamy sands and sandy loams), of 40-50 on medium-textured soils (very fine sandy loams and silt loams), and of 50-60 on fine-textured soils (silty clay loams, silty clays, etc.). Starting irrigations in this range insures maintaining readily available soil moisture at all times. It also provides a safety factor to compensate for practical problems such as the time delay required to cover an entire field and the inability to obtain uniform distribution of the field controlled by the tensiometer station.</td>
</tr>
<tr>
<td>Dry</td>
<td>70</td>
<td>Stress range. Some soil moisture is still available to the plant but is getting dangerously low for maximum production.</td>
</tr>
<tr>
<td></td>
<td>80</td>
<td>Top range of accuracy of tensiometer. Readings above this are possible, but the tensiometer will usually break tension (vacuum is destroyed and dial reading drops to zero) between dial reading of 80 and 85.</td>
</tr>
</tbody>
</table>

that have leads which extend to the ground surface and attach to the meter. When the blocks are placed in the soil they tend to reach the moisture content of the surrounding soil particles. Since the electrical resistance of the material separating the wires varies with the moisture content, the resistance meter reading gives an indication of moisture content of the soil. As the moisture content increases, the resistance decreases; and vice versa. One portable meter is sufficient for reading any number of blocks.

INSTALLATION AND USE

The electrical resistance blocks are used in "stations" exactly the same as tensiometers and at the depths recommended in Table 2. Unlike tensiometer, resistance blocks must be calibrated for each particular soil to give meaning to the meter reading when compared to moisture content. This may be done by comparing an individual reading with the moisture content of an oven-dried sample taken at the same time or by comparing the resistance reading with a tensiometer reading taken in the same area.

When installing resistance blocks, keep the following suggestions in mind:

1. Install the blocks before the root system fully develops.
2. Remove air from the block by soaking in water according to the manufacturer's recommendations.
3. Bore a hole with a soil probe to the desired depth with each block in a separate hole.

4. Crumble the last three inches of soil removed and put it back in the hole along with about one-half cup of water so that a slurry of mud is formed at the bottom.
5. Hold on to the lead wires and push the block firmly into the hole with a stick or rod to insure good contact between the soil and the block. Refill the hole a few inches at a time while firmly tamping the soil.
6. Stake the leads and mark them for future identification.
INTERPRETATION OF RESISTANCE METER READINGS

Salt content has an effect on meter readings so it is difficult to give definite values for any particular moisture content. As a general rule, readings within the following ranges would be found:

<table>
<thead>
<tr>
<th>Condition</th>
<th>Readings</th>
</tr>
</thead>
<tbody>
<tr>
<td>Field capacity</td>
<td>180-160</td>
</tr>
<tr>
<td>Irrigation range</td>
<td>130-80</td>
</tr>
<tr>
<td>Dry</td>
<td>Less than 60</td>
</tr>
</tbody>
</table>

Irrigations would usually begin as follows:

- Loamy sands: 120
- Very fine sandy loams to silt loams: 100
- Clay loams to silty clay loams: 80

Again, these are generalities and each particular field may be different.

COMBINATION OF METHODS

Proper development of the feel method should be accomplished in conjunction with a system of tensiometers or resistance blocks. By observing the condition of a soil sample taken with a soil probe and by correlating this with tensiometer or resistance block readings in the same locality, a reference point is developed from which the moisture conditions of the entire field may be evaluated from samples taken in other areas.