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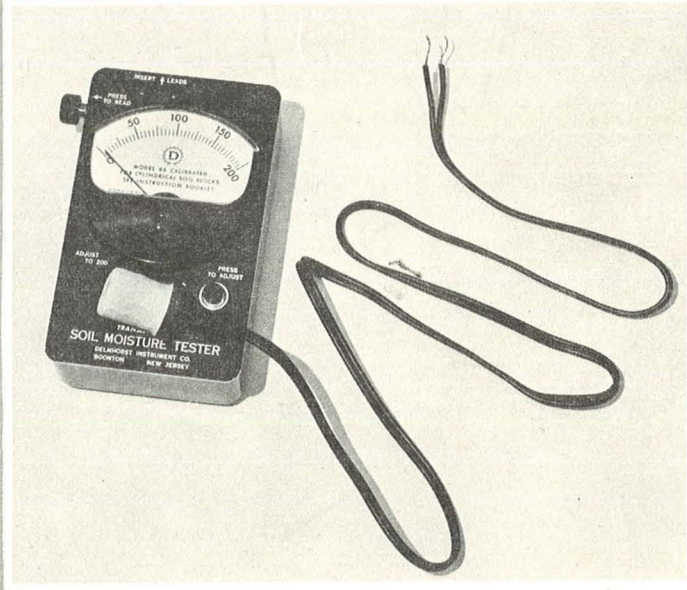
Scheduling Irrigations by ELECTRICAL RESISTANCE BLOCKS



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Scheduling Irrigations by Electrical Resistance Blocks

By Paul E. Fischbach[1]

Delay of irrigation for a few days during a critical part of the growing season can be expensive. A week's delay in supplying irrigation water to corn or grain sorghum can reduce potential yield more than 30 bushels per acre.

Not enough soil moisture will reduce crop yields. But too much water can have the same effect. Excessive irrigation will reduce yields by leaching nitrates beyond the reach of the crop's root system. Too much water can also lower the air content of soil and reduce yields.

Several methods are available to help you schedule the right amount of water at the right time. One of these methods uses electrical resistance blocks to determine the depth .of water penetration and to help select the proper stream flow down the furrows.

Using this method can pay big dividends—about $30 per acre. Improved irrigation management will result in a 30-bushel-per-acre increase at $1 per bushel.

Cost of the electrical resistance blocks, and an electrical meter, for 160 acres is about $125 (78 cents per acre). So, for 78 cents an acre investment, income may increase $30.

What are Electrical Resistance Blocks

The electrical resistance block system uses small gypsum blocks and a portable resistance meter to measure soil moisture content.

Gypsum blocks are made by casting gypsum around a pair of stainless steel wires or wire grids. These wires are attached to lead-wires which are plugged into the meter. When the blocks are placed in contact with the soil, the moisture content of the gypsum tends to equal the moisture content of the soil. Because the electrical

[1]Extension Irrigationist.

resistance of the wires in the gypsum varies with the moisture content, a measurement of electrical resistance by the meter is a good indication of the soil moisture content. The drier the soil, the greater the electrical resistance, and vice-versa. Some meters are constructed so a low gauge reading indicates low soil moisture and a high gauge reading indicates high soil moisture.

Ordinarily, gypsum blocks are placed in the soil, in the rooting zone of the crop, and are left in the soil throughout the growing season. The placement, operation, and use of information from the blocks is described in this circular.

Electrical resistance blocks are placed in groups at several depths in the soil, to provide for a zone of moisture control during root growth and development. Each group of blocks is called a "station," and consists of two or more blocks installed at various depths in the soil, usually in the crop row.

Where to Place Electrical Resistance Blocks

Four stations will generally be needed for each field.

Place two stations in the first irrigation set, with a station about 50 feet from each end of the field in the same crop row. Place the other two stations in the last irrigation set, with a station about 50 feet from each end of the field.

Stations in the first irrigation set and last irrigation set will determine when and where to start irrigating in case a rain should disrupt the irrigation schedule.

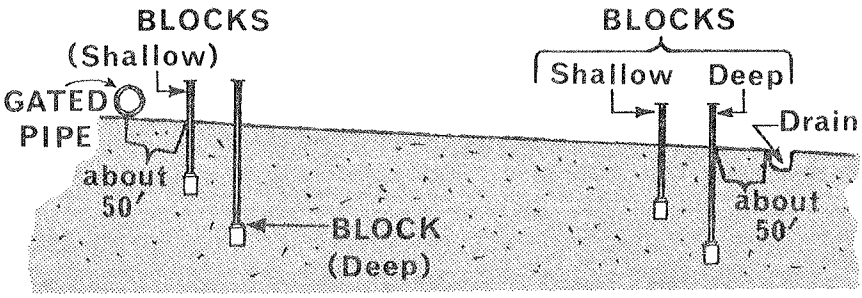
Some general guidelines for locating each station:

1. Place electrical resistance blocks in the row and angle them toward the furrow. The shallow electrical resistance blocks should be under the edge of the furrow and the deep blocks under the center of the furrow when using the blocks for furrow irrigation. Place the blocks in the row and straight up and down for sprinkler irrigation.

2. Locate the stations in representative areas of the field. Don't place the blocks in low or high spots in the field or near changes in slope of the irrigation run unless you wish to measure difference in water penetration caused by changes in slope.

3. Select a station where the plant population is representative of the field.

Location of Electrical Resistant Blocks

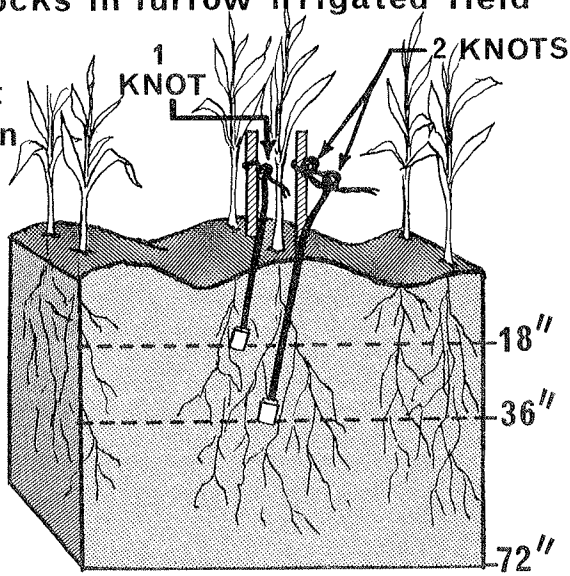


4. Keep the soil around the electrical resistance block stations from becoming compacted when taking readings. Don't walk in furrows in which soil moisture readings are being measured. Walk in the next furrow. Mark each "walk" furrow when installing the resistance blocks.

5. When using sprinkler systems, make sure the blocks are set so they will not be damaged when the sprinkler is moved. Inaccurate readings can result if the blocks are placed too close to a sprinkler head.

For installation procedure, see page 10.

Location of blocks in furrow irrigated field in relation to maximum root development on a deep soil



Depth of Installation

The active root zone of the crop determines the depth of the electrical resistance block installation. The active root zone depends upon the crop irrigated, the depth of the soil, and the stage of growth.

Consider the stage of growth when scheduling irrigations. When the seeds are first planted it may be necessary to irrigate to insure quick and uniform seed germination. Visual inspection of the soil near the seeds will indicate whether an irrigation is needed then. Soil moisture should be at field capacity to the depth of the entire root zone at planting time. Electrical resistance blocks could be installed at 6-inch intervals to the depth of the potential root zone. This would allow the irrigator to chart the soil moisture extraction pattern as the root system develops during the growing season. See Table 1 for root zones of various crops.

Soil depth may be the limiting factor in determining the active root zone. Soils that have less than 6 feet of loamy sand or finer texture soil overlying sand and gravel or an impermeable layer, limit the potential root zone of the deeper rooting crops.

Table 1. Root Zones of Various Crops.

Crop	*Potential*[a] *Root zone (Inches)*	*Active*[b] *Root zone (Inches)*
Corn Sorghum Alfalfa Tomatoes Wheat	72 or greater	48
Sugar Beets Soybeans Field Beans Potatoes	60	36
Pasture	36	24
Onions Blue Grass Lawns	24	18

[a]Potential Root Zone is the depth to which roots of various crops will penetrate if root development is not restricted by soil depth or impermeable formation.

[b]Active Root Zone is the depth from which most of the soil moisture is extracted during the growing season if soil depth is not limiting the root zone.

Table 2. Recommended depths for placing electrical resistance blocks according to soil depth or active root zones.

Soil Depth or Active Root Zone (Inches)	*Shallow Blocks (Inches)*	*Deep Blocks (Inches)*
18	8	12
24	12	18
36	12	24
48	18	36

When soil depth is limiting consider soil depth rather than active root zone when determining how deep the electrical resistance blocks should be placed. Determine the soil depth by field inspection. Table 2 gives recommended depths for setting the electrical resistance blocks according to soil depth or active root zone. A minimum of three blocks per station is recommended; two shallow, one deep.

For example, for a deep rooted crop such as corn or grain sorghum, in which the active root zone is 48 inches (Table 1) on a soil which is deeper than 48 inches (Table 2), electrical resistance blocks installed at a depth of 18 and 36 inches are recommended for each station (Table 2). However, if the soil depth is only 24 inches instead of 48 inches or deeper the electrical resistance blocks installed at a depth of 12 and 18 inches are recommended for each station (Table 2).

Meter Readings as Related to Soil Moisture

Table 3 is a guide to interpreting meter readings as they relate to soil moisture conditions. There will be differences in electrical resistance readings due to frequency of the A.C. resistance meters. Each company that sells electrical resistance meters for measuring soil moisture has recommendations which are provided with the meters.

Scheduling Irrigation, Determining Soil Texture

The meter readings that indicate the need for irrigation will be different for various textured soils (Table 4). Determine your soil texture by field inspection or ask your county agent.

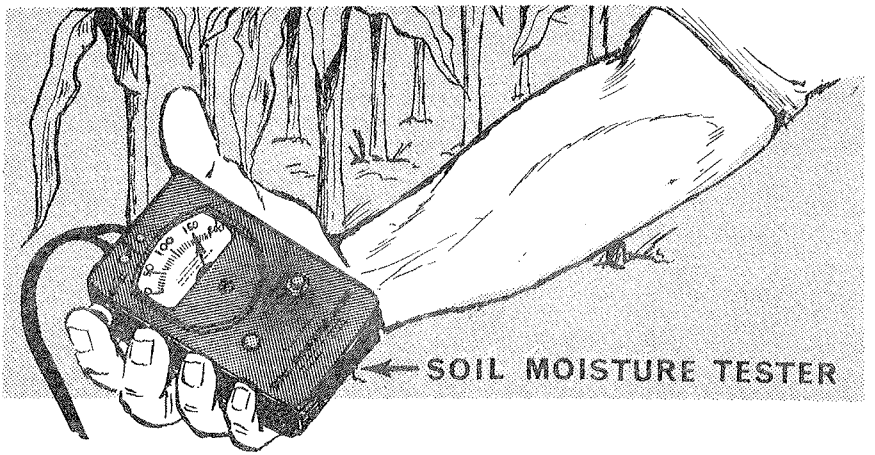


Table 3. Interpretation of readings on the electrical resistance meters as related to soil moisture tension.

	Bars Tension	*Meter Readings*	*Interpretation*
Nearly Saturated	Less than 0.20	200 to 180	Near saturated soil often occurs for a few hours following irrigation. Danger of water-logged soils, a high water table, poor soil aeration if reading persists for several days.
Field Capacity	0.20 to 0.32	180 to 160	Field Capacity. Irrigations discontinued in this range to prevent waste by deep percolation and leaching of nutrients below the root zone.
Irrigation Range	0.65 to 1.2	140 to 100	Usual range for starting irrigations. Soil aeration is assured in this range. Starting irrigations in this range insured maintaining readily available soil moisture at all times.
Dry	1.6	Less than 60	This is the stress range. However, crop not necessarily damaged or yield reduced. Some soil moisture is available to the plant but is getting dangerously low for maximum production.

Table 4. Electrical resistance meter readings for starting irrigation of corn and grain sorghum.

Soil texture	*Meter readings on shallow block*	
	Meter reading	*Bars tension*
Loamy sands Sandy loams	140	0.65
Very fine sandy loams Silt loams	120	0.85
Clay loams Silty clay loams	100	1.2

Irrigation should be started sooner on a sandy soil than on a clay soil, because sandy soils contain less water than clay soils at the same meter reading. Adjustments have also been made in the recommended meter reading to allow for 5 to 8 days to completely irrigate all fields supplied by one water source.

Start Irrigation

Start the first irrigation when the *average* meter readings from the shallow blocks in the first irrigation set reach the meter readings indicated in Table 4 for your soil texture.

There will be some differences in meter readings from station to station, from blocks placed at the same depth due to soil differences, effects of previous irrigations and root growth differences.

Stop Irrigation

Early in the growing season irrigation should be stopped when the meter reading shows a wet condition on the shallow blocks. On later irrigations, if the electrical resistance meter readings on the deep blocks have reached the values in Table 4 before irrigation, indicating that roots are developing and extracting moisture at this depth, stop irrigating when the meter readings show a wet condition on the deep blocks. If the meter readings on the deep block have not changed to the values in Table 4 before irrigation, indicating that root activity is still greater at the shallow block level, then stop irrigating when the meter readings show a wet condition on the shallow blocks.

Evaluating Water Distribution

The blocks should be located in threes—two shallow, the other deep—at each station. The two stations—one at the upper end of the irrigation run and the other at the lower end of the run and in the same row——allow the irrigator to evaluate water penetration on the first irrigation set.

For example, if the meter readings from the blocks located at the various depths show that water penetrated to a depth of 36 inches or more on the upper end of the run and that water penetrated less than 18 inches deep on the lower end of the run then the furrow stream was too small and should be increased on the next irrigation set.

The irrigator will need to judge how much it should be increased. If the stream size must be increased to a point where the furrow stream size will cause serious erosion, then the length of the irrigation run should be shortened.

Installation of the Blocks

1. The electrical resistance blocks should be thoroughly soaked in a pail of water before installing (see manufacturer's recommendations for soaking time). Soaking removes air from the blocks and insures accurate readings of the soil moisture.

2. A soil probe or auger is used to bore a hole in the row slightly larger than the electrical resistance block. Angle the hole toward the furrow. The shallow blocks should be about under the edge of the furrow and the deep block about under the furrow. Make each hole the desired depth—each block should be placed in a separate hole.

3. Crumble up the last 3 inches of soil removed from the hole and put it back in the hole. Pour about ½ cup of water into the hole so a slurry of mud is formed in the bottom.

4. Hold on to the wire lead of the block and push the block into the hole with the soil probe, or ½ inch diameter electrical conduit, setting it solidly in the bottom with a firm push of the probe. *Firm contact between the block and surrounding soil must be made.*

5. Fill the hole with soil, 3 or 4 inches at a time, tamping the soil firmly as the hole is filled.

6. Stake the wire leads. Bring the wire leads from the blocks at a single station together at a stake midway between the holes and tie them to the stake. Make sure you can tell the wires apart. A good

way to do this is to tie a single knot in the shallow blocks and two knots in the one placed deeper in the soil. Another way is to color code the lead wires with various colored plastic tubing.

Install blocks as soon as possible, even before lay-by time if possible, to allow time for the plant roots to grow around the electrical resistance block. If the blocks are installed late in the growing season, it may create problems in securing representative electrical resistance readings.

In making the hole to install the blocks after the root system is mostly developed many of the roots will be cut off near the area where the block is installed. These roots may or may not grow back near the electrical resistance block. Therefore, it is best to install the blocks early in the growing season before the root system has developed very extensively.

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