Electrical Resistance Gypsum Blocks For Scheduling Irrigations

Cooperative Extension Service
Oregon State University
Corvallis

Extension Bulletin 810
March 1963
Figure 1. Electrical resistance soil moisture measuring equipment used in Oregon: (1) Coleman, (2) Irrigage (Rader meter not shown is similar), (3) Buycous (converted), (4) Delmhorst, (5) adapter to single block units, (6) single block units, (7) block units assembled on Jones plug. A switch on meters 1, 2, and 3 can be used to select individual block units to be read when they are assembled on a Jones plug.

Cover: Cliff Hess, Douglas County farmer, explains his soil moisture-measuring program at an irrigation meeting.
Electrical resistance gypsum blocks have been used by farmers in Oregon since 1952. They have proved an effective aid to efficient irrigation on farms when used according to recommended procedures. Oregon State University has conducted extensive research to determine what characteristics make equipment convenient and reliable under Oregon conditions. The Delmhorst gypsum blocks referred to in this circular were evaluated by OSU in 1962 and were the only type sold commercially in quantity in Oregon at the time of writing. For this reason, only limited reference has been made to other types which have been developed through the years. A wide variety of meters and equipment can be used with these moisture-measuring blocks. It has been necessary to use trade names throughout this bulletin, but no endorsement is made of one brand over another, nor is criticism intended of equipment not mentioned.

Equipment

The measuring equipment consists of a portable meter and gypsum blocks (Figure 1, page 2).

The blocks are a casting of a special gypsum mix around two stainless steel coils (Figure 2) that are attached to wire leads extending above the ground. When a reading is made, the meter is attached to the leads and the amount of current flowing through the block at a specified voltage is measured to determine the amount of resistance present.

The amount of water in the gypsum block will increase or decrease as the amount of water in the soil surrounding the block increases or decreases. This results in resistance changes within the block, which can be interpreted in terms of moisture content of the soil.

Calibration

Figure 3 is a calibration of the Delmhorst cylindrical gypsum block.
Irrigation recommendations are expressed in terms of moisture tension (a measure of the availability of water to plants) to make them applicable across a range of soil textures.

Another type of calibration is shown in Figure 4. This calibration can be used on nearly all medium to fine textured soils which are not underlain with coarse sand. It is quite useful; however, it is not as accurate as the type of calibration shown in Figure 3. Seasonal soil temperature changes may cause the calibration to shift slightly. However, for the extremes occurring in Oregon at the depths the blocks are installed, this shift will have little practical significance.

Figure 3. Calibration of Delmhorst cylindrical gypsum block.
Figure 4. Another type of calibration of Delmhorst cylindrical gypsum blocks.

Limitations
Movement of water in and out of the block requires good contact between the soil and the block. This is frequently difficult to maintain in coarse sandy soil, or in fine adobe soil which shrinks and swells considerably between irrigations. These soils are found only in isolated areas in Oregon.

Soils high in salt also may cause erratic resistance readings; however, from a practical standpoint, the blocks will work satisfactorily in any soil that does not exhibit saline or alkaline problems.

Number of installations required
Gypsum blocks measure moisture content only in the soil immediately surrounding them. This measurement is projected over larger areas of the field. It is important, therefore, that the location of the blocks be "representative" of the larger areas both as to moisture-holding capacity and crop-root concentration.

A minimum installation for a sprinkler irrigated area requiring more than four days to irrigate and having uniform soil is four strings of four blocks each (total 16 blocks) usually installed.
6, 12, 18, and 24 inches deep. Make installations in pairs as shown in Figure 5. The two at the start indicate when to begin irrigation; those at the end indicate how dry it got before irrigation was completed.

In the case of surface irrigation when corrugations or rills are used, install the blocks between the corrugations or rills one fourth of the way from the top and bottom of the run as shown in Figure 6. Make duplicate installations between other corrugations or rills 5 to 10 feet away.

Install them in the area of highest root concentration (in the row) and on knolls rather than in swales. Adapt the depths the blocks are buried to the rooting depth of the crop. Make extra installations when there are wide variations in soil texture and the areas involved are important.

**Installation procedure**

Figure 7 shows the six steps involved in the installation of gypsum blocks. Install them when the soil is moist if at all possible. It is easier, and the blocks will reach equilibrium with the soil in less time.

**Reading schedules and records**

Read blocks every two days for best results. Plot the readings on charts (Figure 8) and place charts at a convenient, frequently visited location. Charts are available from county Extension offices.

Have one person responsible for the reading. High school students can do a very satisfactory job. In some counties, farmers have organized and hired one person to take and chart all of their readings.

**Interpretation of readings**

As a general irrigation recommendation, one-half of the root system should be kept wetter than 2 bars tension. This corresponds to 5,500 ohms resistance (85 on the chart in Figure 4). Some crops (fresh market for example) will respond to wetter treatment while others (forage) will tolerate drier treatments.

Active roots are indicated whenever readings drop. By plotting all the depths of one installation on a single chart, the depth of rooting is immediately apparent—providing the blocks are deeper than the roots. In Figure 7, on July 10 roots were taking moisture at the 6- and 12-inch depths but not at the 18-inch depth.

By extending the slope of the lines (Figure 8), it is possible to predict when an irrigation should be applied days before it is actually needed. On July 31 a reading of 50 could be predicted for the 6-inch depth and 120 for the 18-inch depth on August 7. Extreme hot weather will steepen the slope and cool, cloudy weather will flatten it out.

Whenever the soil moisture changes, the meter readings change. By observing the change in meter readings at different soil depths, the adequacy of an irrigation becomes apparent. On July 20 the irrigation wet the 6-inch depth but not the 12. It, therefore, did not refill the soil profile. On August 8 all depths were refilled.

When the available moisture-holding capacity of a soil is known, a chart similar to Figure 9 can be used to predict the amount of moisture required to fill the root zone. Charts for specific soils can be obtained from the Soil Physics Laboratory, OSU, by request through a county Extension agent. To use the chart, note that readings made with an “Irrigage” meter on August 8 in Figure 8 were 6” = 50, 12” = 90, 18” = 120, 24” = 190. Then use the procedure shown on pages 10 and 11.
Figure 5. Location of gypsum block installations in a uniform field under sprinklers.

Figure 6. Location of gypsum block installations in a uniform field under corrugations.
Figure 7. Left—(1) Soak the blocks in water for two to three minutes; (2) dig a hole with a 7/8" soil probe; (3) make a soil and water slurry of creamy consistency and place one or two tablespoons of slurry in the hole. Right—(4) Push block to the bottom of the hole, forcing slurry to come up around it; (5) backfill and tamp two or three inches at a time; and (6) install only one block in each hole and fasten the leads to a stake.
Figure 8. Typical soil moisture chart. Actual charts are twice this size.
Procedure for determining amount of water to apply:

1. Take meter reading (Irrigage) for depth measured and move across chart to right until calibration curve is reached.

2. Drop straight down and read amount of water required to bring this depth back to field capacity.

3. Do the same for each depth.

4. Then:
   a. Add 0.4” (for the 0” to 3” of soil depth).
   b. Total these moisture requirements.
   c. Increase the total amount by \( \frac{1}{3} \) to allow for evaporation, wind distortion of sprinkler pattern, etc.

5. The total is the approximate amount of water required to bring the soil profile back to field capacity.
If, after applying the calculated irrigation requirement, the soil does not return to field capacity at all depths, it may be because of uneven distribution from the sprinklers, or the moisture-holding capacity of the soil may differ from that indicated in the chart. If caused by using wrong moisture-holding-capacity information, adjustments can be made by evaluating block readings following an irrigation.

If there are differences of more than 25 points between meter readings of blocks at similar depths located near each other, the cause should be determined. The difference may be caused by poor distribution of water, differences in root concentrations surrounding the installations, or soil differences. When the cause and importance of the problem is determined, a decision regarding corrective action may be taken. This may involve using the driest installation as the guide for scheduling, correcting sprinkler distribution, or relocating the block installation.

<table>
<thead>
<tr>
<th>Depth of unit</th>
<th>Soil depth measured</th>
<th>Meter reading</th>
<th>Inches H₂O required</th>
</tr>
</thead>
<tbody>
<tr>
<td>6&quot;</td>
<td>3&quot; - 9&quot;</td>
<td>50</td>
<td>0.8</td>
</tr>
<tr>
<td>12&quot;</td>
<td>9&quot; - 15&quot;</td>
<td>90</td>
<td>0.6</td>
</tr>
<tr>
<td>18&quot;</td>
<td>15&quot; - 21&quot;</td>
<td>120</td>
<td>0.5</td>
</tr>
<tr>
<td>24&quot;</td>
<td>21&quot; - 27&quot;</td>
<td>190</td>
<td>0.0</td>
</tr>
</tbody>
</table>

\[ \text{Plus } \frac{1}{4} \text{ for application losses} = 0.7 \]

\[ \text{Total irrigation required} = 3.0 \]