Agriculture Notes

Gypsum blocks for measuring the dryness of soil

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What is a gypsum block?

Gypsum blocks measure soil water tension, a reflection of the force that a plant must overcome to extract water from the soil. Gypsum blocks measure tension in dry soil. Tensiometers similarly measure soil water tension but in wet and moist soil. (See Agriculture Note AG0298* How to use tensiometers*.)

Gypsum blocks consist of two electrodes embedded in a block of gypsum. They can be either cylindrical or rectangular in shape with concentric or parallel electrodes (Figure 1). Wires are joined onto each electrode and extruded from the gypsum block to measure the resistance between the electrodes. The resistance between the two electrodes varies with the water content in the gypsum block, which will depend directly on the soil water tension. As the soil dries out water is extracted from the gypsum block and the resistance between the electrodes increases. Conversely as the soil wets, water is drawn back into the gypsum block and the resistance decreases.

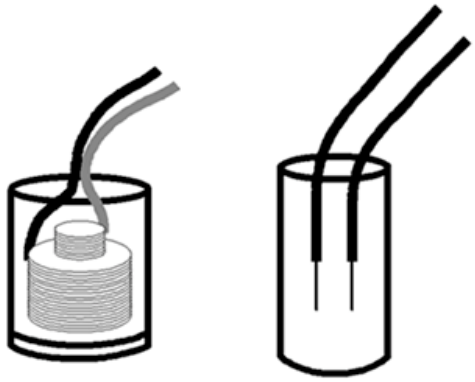

Figure 1. Internal arrangement of electrodes in cylindrical gypsum blocks showing concentric electrodes (left) and parallel bare soldered wire electrodes (right).

How to measure gypsum blocks

Gypsum blocks are measured either directly with a portable meter, or remotely by a sophisticated irrigation controller. For people with knowledge of electronics it is possible to make a meter. To prevent polarisation of the gypsum block an alternating current circuit must be used to measure the impedance (resistance and reactance) between the two electrodes. One method is to apply an oscillating voltage and measure, in series with a multimeter, the alternating current flowing through the gypsum block. Gypsum block resistance is simply calculated by dividing the power supply voltage by the multimeter current reading. Calibration curves to convert the meter reading to soil water tension are available for the various commercial gypsum blocks (Figure 2).

There are also several commercial meters available which read directly in units of kilopascals (kPa) or bars. Note however, that each commercial meter is specific to the corresponding manufacturer's gypsum block.

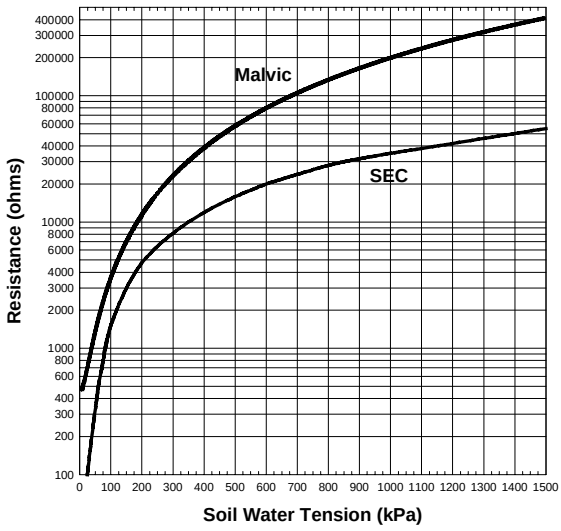

Figure 2. Typical calibration curves for two commercial gypsum blocks. The vertical axis shows the resistance in ohms as either measured by the meter and the horizontal axis shows the tension at which water is held in the soil. For example, if the resistance is 10,000 ohms for a SEC (Soilmoisture Equipment Corporation) block, the soil water tension is 345 kPa (or 3.45 bars).

Interpretation of the reading

Gypsum blocks measure soil water tension in the range from 30 to 1500 kPa. In soil wetter than 30 kPa they become inaccurate. Their application to maintain soil close to field capacity is limited. They are, however, very

useful for conditions in the drier range. In soil drier than 50 kPa, the tree or vine must work hard to extract water and is therefore stressed. Under most conditions irrigation should be applied. There are, however, periods during a growing season when soil moisture conditions drier than 50 kPa are advantageous. For example, the irrigation management technique called Regulated Deficit Irrigation (RDI). In this situation, gypsum blocks are extremely useful as a guide to prevent over-stressing the tree.

Irrigating from gypsum blocks

Gypsum blocks located at several depths in the soil are used to determine when to begin and when to turn off irrigation. Depending on the irrigation strategy (eg. RDI), gypsum blocks located in the upper fibrous root zone or in the lower part of the root zone can be used to determine when to irrigate. For instance, under optimal water requirements the top gypsum block in the fibrous root zone will determine when to begin an irrigation and the lower gypsum block when to turn off irrigation to prevent over or under-watering. If stress is required (eg. RDI) then all gypsum blocks in the root zone are observed until they are drier than the recommended soil water tension.

Placement in the soil

The first step is to locate the active root zone. Roots will generally be found in the tree-line. Use a shovel, auger or backhoe to determine their depth. Two or three gypsum blocks are then placed down the soil profile (Figure 3). The gypsum block closest to the soil surface must be sited in the middle of the wetting front where it becomes wet at each irrigation. For trickle and micro-irrigation, this is as close as practical to the outlet without having ponding of water where the gypsum blocks are installed. For sprinklers, a site that is representative of the average soil moisture should be chosen. Each site must be close to the tree-line to avoid slashing of the leads, and clearly marked.

The depth of the gypsum blocks is governed by the root depth. If roots extend below 800 mm then three gypsum blocks should be installed at 300 and 600 mm and at the bottom of the root zone. If roots are confined to the top 800 mm then only two gypsum blocks in the middle of the fibrous root zone (usually 200 or 300 mm depth) and the bottom of the root zone need to be installed. The deepest gypsum block is very useful to determine when to irrigate after rainfall or at the start of a stress period.

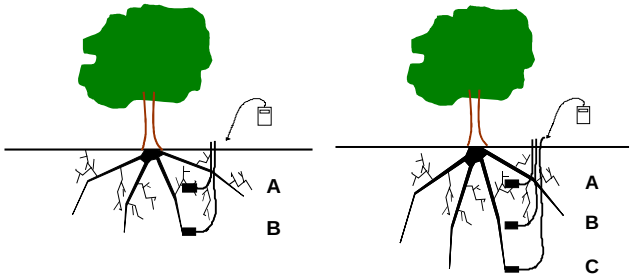

Figure 3. Position of soil moisture sensors in shallow root zones (left) and in deep root zones (right). Position A determines when to irrigate to maintain optimum growth, position B determines how much to irrigate and position C helps to determine when to irrigate during RDI or if irrigation water is limited.

An auger is best used for the installation (Figure 4). The soil should be laid out as it is removed from the auger in such a way that it can be replaced. A separate hole is best for each depth. The hole can be augered at an angle of 45 degrees to the horizontal to prevent preferential water penetration down the backfilled augered hole. If there is considerable variation in soil type then gypsum blocks should be sited in each soil type and the irrigation laid out so that each soil type can be irrigated separately.

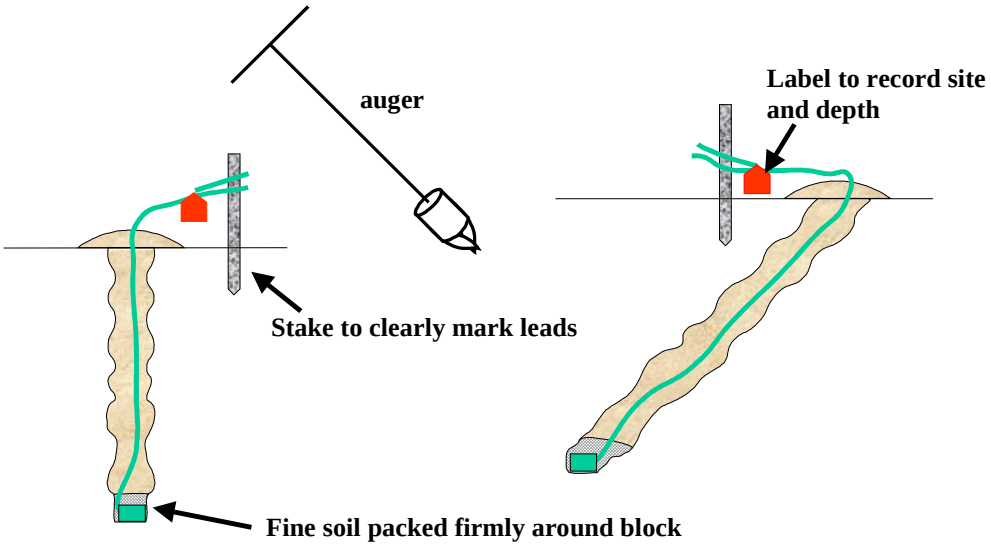

Figure 4. Installation of gypsum blocks showing a vertical installation (left) and an angle installation to prevent preferential flow (right) with typical soil auger, stake to mark their position and label indicating depth.

Trouble shooting

Gypsum blocks, when compared to tensiometers, are maintenance free and measure soil moisture well outside the range of a tensiometer. They are, however, sensitive to temperature, salinity and high levels of nitrogen fertiliser. Temperature has little effect in field applications largely because the soil buffers against daily soil temperature variation. When the salinity of the irrigation water exceeds 2000 parts per million or the soil salinity of a saturated soil solution is greater than 6.0 dS/m, errors arise in gypsum block readings. These conditions rarely occur. To test if there is a problem from salinity or fertiliser, gypsum blocks should be read immediately following irrigation. If the resistance of the block falls well below the calibration curve at 0 kPa then there is a problem and the gypsum block will be unreliable as the soil dries out. One other problem is that the blocks have a life span of between three and five years. Gypsum dissolves and eventually there is no media between the electrodes in the gypsum blocks. Their cheapness and simplicity, however, outweigh their limited life span.