Measuring Water Content in Soil-less Media Using ECH_2O Probes

Colin S. Campbell, Douglas R. Cobos, Brody L. Teare, Jeffrey E. Ritter

Introduction

Since the introduction of the ECH_2O soil moisture probe, there has been considerable interest in using them to measure volumetric water content of soil-less media such as potting soils, rockwool, and perlite. While it was possible to measure volumetric water content with the EC-10 and EC-20, their insensitivity to changes in water content above about 50% volumetric water content (VWC) made their use difficult in high porosity media.

The introduction of the EC-5 and ECH_2O-TE (-TE) probes has made this measurement easier, more accurate, and more repeatable. The multi-prong design of the EC-5 and -TE allows for easy insertion into organic media, while the space between the prongs helps maintain sensitivity to 100% VWC, and the higher frequency of the measurement circuitry reduces the probes sensitivity to electrical conductivity and media type. Applications of these measurements include potted plant and greenhouse studies, where planting media typically have a high organic component, and seasonally flooded wetlands

Because of the unique makeup of various soil-less media, it is important to approach VWC measurement in these materials with caution. Calibrations that work for one media type may not work well for another. For this reason, if a high amount of accuracy is required, users are encouraged to follow the calibration procedure in this note to obtain their own calibration.

The objective of this note is to present the procedure and results of calibration tests on soil-less media including potting soil, rockwool, and perlite.

Materials and Methods

The ECH_2O-TE and EC-5 probes were calibrated in three media types: potting soil (Nursery Blend (Bountiful Farms)), Sunshine Mix, and Miracle Grow ("Potting Soil"), rockwool ("Master", Grodan), and fine perlite. The EC-5 was tested at two different excitation voltages. Because of the unique qualities of each material, calibration procedures were developed for each media type.

Potting Soil

The general procedure of the potting soil calibration was to incrementally wet up the soil while collecting probe output and actual VWC data across the important range of water contents. The potting soil had pore water electrical conductivities of 3.1, 5.3 dS/m (Bountiful Farms), <1 dS/m (Sunshine), and 8.3 dS/m (Miracle Grow).

Each experiment started with near air-dry potting soil. A sub sample of the material was gently packed into a 250 ml beaker to a volume of approximately 200 ml and the ECH_2O-TE and EC-5 probes were inserted fully (up to the black overmold) into the media and a reading taken. The beaker of soil was then weighed, dried in an oven at 70 C and for 48 h, and weighed again.

VWC was determined using the gravimetric water content and the volume of the sample (determined as closely as possible from the volume increments on the beaker). This step was repeated at a total of five VWC's by adding water to the potting soil between each measurement. The volume of water added at each increment was roughly calculated so the potting soil VWC change was approximately 10%. Calibration curves were made by plotting actual VWC with probe output.

Rockwool

The rockwool calibration procedure was entirely different from potting soil. Because it has approximately 97% porosity, a hanging water column was used to extract known amounts of water from the sample. A known volume of dry rockwool was weighted and placed in a sintered glass funnel (350 ml, Pyrex Model 36060) attached to a 1.26 cm i.d. PVC tube that was pre-marked with known volume increments.

The tube was filled and water was allowed to infiltrate into the rockwool from the bottom until it was saturated with water. Water level in the hanging water column tube was adjusted to the lowest volume mark. The EC-5 and ECH_2O-TE probes were installed in the rockwool and the tube height changed to slowly drain the water. VWC and probe output were recorded at each volume increment (13 ml). Once tension was broken (usually around 10 to 20 % VWC), the rockwool was taken out and weighed to calculate final VWC. VWC and probe output were plotted together to determine a calibration function. The process was repeated at various electrical conductivities (EC) to show how output changed at various EC levels.

Perlite

The perlite calibration technique followed the one used for potting soil except for the sampling of actual VWC. In the case of perlite, a small 10 ml sub sample was collected with a commercial volume sampler (ESS Lock N' Load Handle and Syringe, Environmental Sampling Supply, Model LL), weighed, dried, and weighed again.

Results and Discussion

Changes in EC-5 output with VWC were different for each of the media types tested, but were consistent within media type (Figs. 1-3). From the data collected, no significant changes in probe calibration were observed due to changes in pore water electrical conductivity in the ranges we tested (Fig. 1). In addition, the potting soil calibration appeared to be unaffected by changes in potting soil type. Both of these findings are significant because most potting soils are unique blends of organic and inorganic material as well as fertilizer levels chosen especially for the plant type, stage of development, environmental conditions, etc. It is also interesting to note that the potting soil (Fig. 1), rockwool (Fig. 2) and perlite (Fig. 3) all differ in apparent 0 % VWC value. This is due to differences actual dry media dielectric due primarily to differences in density.

ECH_2O-TE calibrations show similar results to the EC-5 (Fig. 4-5). These findings were expected because they use similar to make the water content measurement. Although not as many potting soils were tested, our findings suggest that, like the EC-5, the same calibration equation can be used for any potting soil type. A complete list of these calibration equations can be found at www.decagon.com/appnotes/ec5TEcal.pdf.

Figure 1. 2.5 and 3.0 V calibration of EC-5 in potting soil. Data are from 5 different probes in 3 types of potting soil. Soil salinities ranged from ~0.5 dS/m to 8.3 dS/m

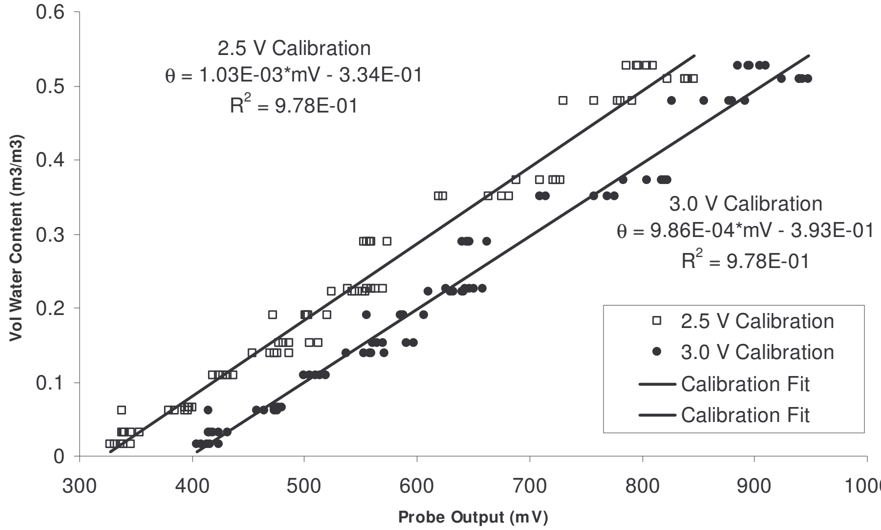


Figure 2. Calibration curve for EC-5 in rockwool at 2.5 V excitation and EC levels of 0.2, 1, 1.5, 1.8, and 4.2 dS/m.

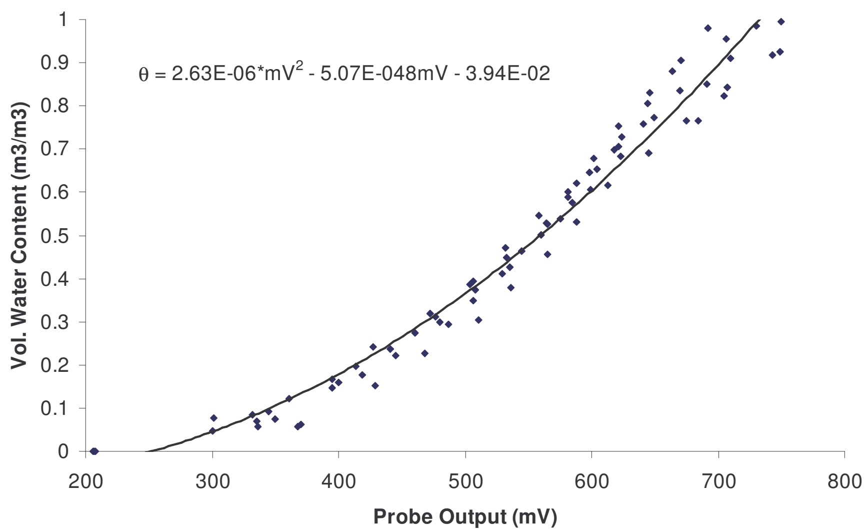


Figure 3. Single calibration curve for EC-5 in perlite at 2.5V excitation.

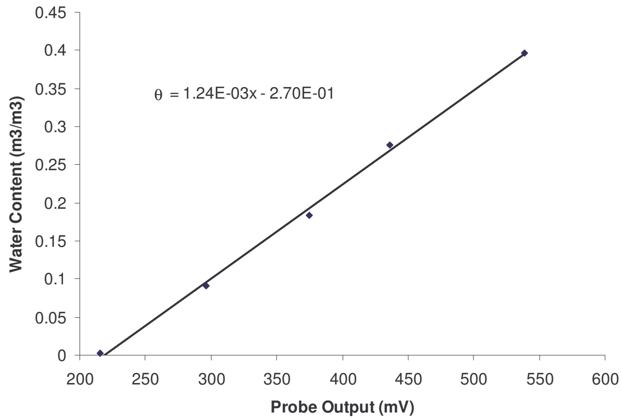


Figure 4. ECH2O-TE calibration in potting soil. Soil electrical conductivities range from 0.5 to 14.5 dS/m.4.

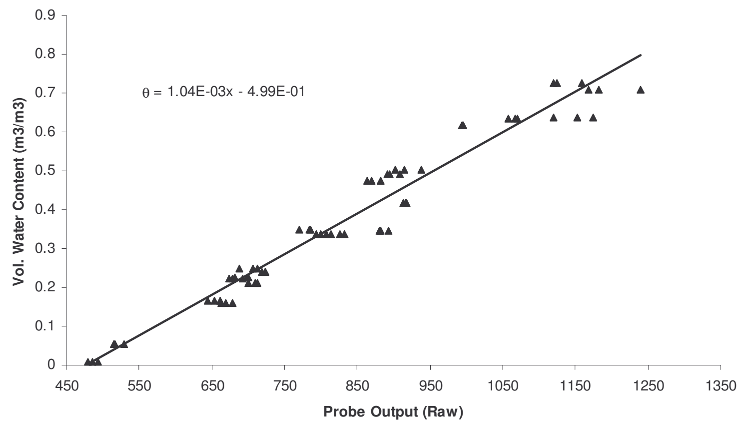
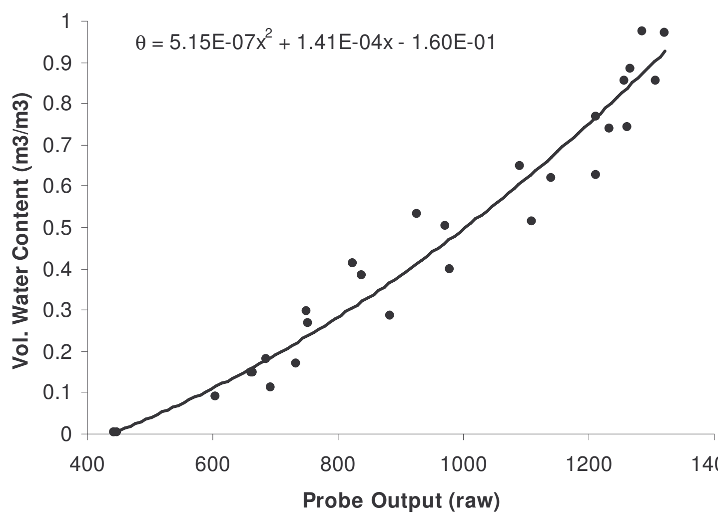


Figure 5. A single ECH$_2$O-TE calibration in rockwool at EC levels of 0.002, 4.1, and 8.1 dS/m.



Decagon Devices, Inc.
2365 NE Hopkins Ct.
Pullman, WA 99163 USA
support@decagon.com
ech2o.decagon.com