

Rapid procedure to calibrate EC-10 and EC-20 capacitance sensors in coir

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ABSTRACT

A rapid calibration procedure for EC-10 and EC-20 sensors is introduced to promote the commercial use of these sensors for hydroponic irrigation management in coir. The method is comprised of taking one sensor reading, by a sensor installed under hydroponic crop production conditions, and one gravimetric sample, both at field water capacity, to determine a correction factor for an accurate general laboratory calibration equation developed for coir. The rapid calibration procedure was evaluated by 4 separate sensors of EC-10 and EC-20. To verify the relative reliability of the rapid procedure, statistical analysis was performed separately for all data points and for data points between the drained upper limit and permanent wilting point of coir. From the statistical parameters used, it was observed that all of the predictions in the plant available water content range were good, with RMSE values $< 0.030 \text{ m}^3 \cdot \text{m}^{-3}$ for the EC-10 and $< 0.021 \text{ m}^3 \cdot \text{m}^{-3}$ for the EC-20 sensors. The D-index also pointed to a high accuracy of prediction in the plant available water content range, with values over 0.981 and 0.990 for the EC-10 and EC-20 sensors, respectively. Since a degree of variation remained between sensors, it was concluded that sensors should be calibrated individually. The rapid procedure proves a simple but scientifically sound method to calibrate sensors and is easy to apply to individual sensors in the field.

Keywords: growing medium, rapid calibration, soil water sensors, water content

INTRODUCTION

Coir is a popular growing medium in hydroponic crop production in South Africa and worldwide (Van der Westhuizen, 2009). Its popularity can be ascribed to improved yields achieved through the use of this medium (Colla et al., 2003; Halmann and Kobryń, 2003). However, coir varies greatly from soil and other growing mediums with regard to water availability, and therefore knowledge on irrigation scheduling in coir is limited and irrigation usually managed poorly. Research by Van der Westhuizen (2009) indicated that irrigation scheduling through capacitance sensors in coir can maintain and even increase yield of hydroponic cucumber and tomato crops, while water use efficiency is greatly improved. It is however important that the water sensors are calibrated specifically for the coir.

Calibration procedures for soil water sensors have been established with the development of these sensors, but there has been very little improvement of these procedures over the years, although sensor technology has changed rapidly and continuously. Starr and Paltineanu (2002) and Cobos and Chambers (2010) detail the calibration procedures for the field and laboratory. Van der Westhuizen and Van Rensburg (2011) highlight some of the major issues encountered with these standard field and laboratory calibration procedures, of which the most critical factors are labour- and time-intensiveness due to the need for destructive sampling, as well as the waiting period required to reach the desired soil water content, and spatial variation in the field or repacking of soil in the laboratory

(Starr and Paltineanu, 2002; Lane and Mackenzie, 2001). The main concern for the standard field and laboratory calibration procedures are that a calibration curve is developed from very few data points. This results in calibration equations derived from single data points which, in addition, do not consider sensor response over time. All of the above-mentioned factors may create concern with regard to the precision and accuracy of calibration.

A new and improved calibration procedure for capacitance sensors in coir, that addresses these problems, has been proposed in detail by Van der Westhuizen and Van Rensburg (2011). Briefly, the method comprises the continuous gravimetric measurement of water content with load cells, as well as the continuous measurement of capacitance sensor output during a drying cycle. The drying cycle is driven by the evaporative demand of the environment as well as the water retention characteristics of the growing medium, in this case coir. Excellent precision fits for sensor response versus volumetric water content (θ_v) were achieved, and water content was predicted with high accuracy (Van der Westhuizen and Van Rensburg, 2011). The calibration procedure of Van der Westhuizen and Van Rensburg (2011) was found to be less labour-intensive, and much more accurate because of an abundance of data points. However, it still requires an extended saturation and drying period, which remains time-consuming, while it may also require some specialised equipment that is not always available to crop producers.

Soil water sensor technology is being used more frequently in commercial crop production because of good results achieved in soil (Thompson et al., 2007). However, although new and improved calibration procedures further improve the accuracy of water content management, it has become necessary to find a balance between the accuracy of calibration for

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