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Assessment of a calibration procedure to estimate soil water content with Sentek Diviner 2000 capacitance probe

G. Rallo, G. Giordano, and G. Provenzano
Department of Agro-Environmental Systems - University of Palermo, Viale delle Scienze 12, 90128 Palermo, Italy

In irrigated systems, soil water content is a major factor determining plant growth. Irrigation scheduling criteria are often related to measurements of soil water content or matric potential. Strategies to manage irrigation can be used to optimize irrigation water use or to maximize crop yield and/or quality, in order to increase the net return for the farmer. Of course, whatever criterion is adopted to schedule irrigation and in particular when crop water stress conditions are considered, the accurate monitoring of the water content in the soil profile, could allow to verify the exact irrigation timing, defined according to the crop response to water stress.
Currently many methods are available for determining soil water content on a volume basis (m3m-3) or a tension basis (MPa), as described by Robinson (2008). Recently, distributed fiber optic temperature measurement, has been assessed as a new technique for indirect and precise estimation of soil water contents.
Over the past decade Frequency Domain Reflectometry (FDR) probes, allowing to measure the apparent dielectric constant of the soil (K), indirectly related to the volumetric water content (θv), have been improved, due to the good potentiality of capacitance based sensors to in situ measurements of soil water content.
However, due to the high variability of K with soil minerals and dry plants tissues, it necessary to proceed to a specific calibration of the sensor for each soil (Baumhardt et al., 2000), even to take into account the effect of soil temperature, bulk density and water salinity (Al Ain et al., 2009).
. According to Paltineanu and Starr (1997), the precision of the calibration equation, obtained with in situ measurements, mainly depends on the errors related to the sampling of the soil volume investigated by the sensor, that must be done accurately. For swelling/shrinking soils, the changes of soil bulk volume with water content cause modifications in the geometry of some if not all the soil pores, affecting the bulk density/water content relationship (Allbrook, 1992). Field experiments in shrinking-swelling clay soils evidenced that soil water content can be affect by errors of 20-30% if the soil shrinkage curve is not considered (Fares et al., 2004).
The main objective of the paper was to propose a practical calibration procedure for FDR sensor using mini-lysimeter containing undisturbed soil, allowing to take in to account the possible variations of the bulk density with the soil water content.
Moreover, the possibility of using disturbed soil samples for determining the sensor calibration curve was also investigated, in order to simplify the proposed methodology.
Experiments were carried out on three different soil, two of which containing a percentage of clay higher than 40%, in order to compare the specific calibration curves with that suggested by the manufactures.
The investigation showed how for swelling/shrinkage soils it is necessary the knowledge of the actual soil bulk density and also that using disturbed soil sample is not possible to consider the effects of the soil shrinkage consequent to the soil water content reductions.