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Irrigation scheduling of green areas based on soil moisture estimation by the active heated fiber optic distributed temperature sensing AHFO

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Irrigation programing determines when and how much water apply to fulfill the plant water requirements depending of its phenology stage and location, and soil water content. Thus, the amount of water, the irrigation time and the irrigation frequency are variables that must be estimated. Likewise, irrigation programing has been based in approaches such as: the determination of plant evapotranspiration and the maintenance of soil water status between a given interval or soil matrix potential. Most of these approaches are based on the measurements of soil water sensors (or tensiometers) located at specific points within the study area which lack of the spatial information of the monitor variable. The information provided in such as few points might not be adequate to characterize the soil water distribution in irrigation systems with poor water application uniformity and thus, it would lead to wrong decisions in irrigation scheduling. Nevertheless, it can be overcome if the active heating pulses distributed fiber optic temperature measurement (AHFO) is used. This estimates the temperature variation along a cable of fiber optic and then, it is correlated with the soil water content. This method applies a known amount of heat to the soil and monitors the temperature evolution, which mainly depends on the soil moisture content. Thus, it allows estimations of soil water content every 12.5 cm along the fiber optic cable, as long as 1500 m (with [U+F0B1]2 % accuracy) , every second.
This study presents the results obtained in a green area located at the ETSI Agronómica, Agroalimentaria y Biosistesmas in Madrid. The area is irrigated by an sprinkler irrigation system which applies water with low uniformity. Also, it has deployed and installation of 147 m of fiber optic cable at 15 cm depth. The Distribute Temperature Sensing unit was a SILIXA ULTIMA SR (Silixa Ltd, UK) with spatial and temporal resolution of 0.29 m and 1 s, respectively. In this study, heat pulses of 7 W/m for 2 min were applied uniformly along the fiber optic cable and the thermal response on an adjacent cable was monitored prior, during and after the irrigation event. Data was logged every 0.3 m and every 5 s then, the heating and drying phase integer (called Tcum) was determined following the approach of Sayde et al., (2010). Thus, the infiltration and redistribution of soil water content was fully characterized.
The results are promising since the water spatial variability within the soil is known and it can be correlated with the water distribution in the irrigation unit to make better irrigation scheduling in the green area improving water/nutrient/energy efficiency..

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