Time-lapse electromagnetic induction surveys under olive tree canopies reveal soil moisture dynamics and controls

Gonzalo Martínez (1), Juan Vicente Giraldez Cervera (2), and Karl Vanderlinden (3)

(1) IFAPA Centro Alameda del Obispo. Avda. Menéndez Pidal sn. Apdo. 3092 14080 Córdoba (Spain). z42magag@uco.es,
(2) Departamento de Agronomía. Campus de Rabanales Universidad de Córdoba. 14071 Córdoba. Spain., (3) IFAPA,
Centro Las Torres-Tomejil, Alcalà del Río (Seville), Spain

Soil moisture (θ) is a critical variable that exerts an important control on plant status and development. Soil sampling, neutron attenuation and electromagnetic methods such as TDR or FDR have been used widely to measure θ and provide point data at a possible range of temporal resolutions. However, these methods require either destructive sampling or permanently installed devices with often limiting measurement depths, or are extremely time-consuming. Moreover, the small support of such measurements compromises its value in heterogeneous soils. To overcome such limitations electromagnetic induction (EMI) can be tested to monitor θ at different spatial and temporal scales. This work investigates the potential of EMI to characterize the spatio-temporal variability of soil moisture from apparent electrical conductivity ($EC_a$) under the canopy of individual olive trees. During one year we measured θ with a frequency of 5 min and $EC_a$ on an approximately weekly basis along transects from the tree trunk towards the inter-row area. CS-616 soil moisture sensors where horizontally installed in the walls of a trench at depths of 0.1, 0.2, 0.4, 0.6 and 0.8 m at five locations along the transect, with a separation of 0.8 m. The Dualem-21S sensor was used to measure weekly the $EC_a$ at 0.2 m increments, from the tree trunk to a distance of 4.4 m. The results showed similar drying and wetting patterns for θ and $EC_a$. Both variables showed a decreasing pattern from the tree trunk towards the drip line, followed by a sharp increment and constant values towards the center of the inter-row space. This pattern reflects clearly the influence of root-zone water uptake under the tree canopy and higher θ values in the inter-row area where root-water uptake is smaller. Time-lapse $EC_a$ data responded to evaporation and infiltration fluxes with the highest sensitivity for the 1 and 1.5 m $EC_a$ signals, as compared to the 0.5 and 3.0 m signals. Overall these preliminary results revealed the potential of EMI to monitor the spatio-temporal variability of soil moisture fluxes under olive tree canopies.