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

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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.