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Characterizing soil-plant interactions under heterogeneous micro-irrigated citrus orchards

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The increased water demand from the irrigated agriculture sector calls for the introduction of more efficient water saving strategies in order to maintain sustainable crop production. This need is particularly urgent in Mediterranean climate areas, already deeply affected by water scarcity and soil depletion issues. In this context, the use of advanced near surface geophysics monitoring techniques can help to characterize the temporal and spatial soil physics dynamics and the related soil moisture processes active at the root-zone level aiming at optimizing the irrigation management.

In this study, the electrical resistivity imaging (ERI) technique was applied for characterizing the mass exchange mechanisms acting within the soil-plant system of heterogeneous micro-irrigated orchards. In particular, repeated ERI surveys were carried out in a citrus orchard (*Citrus sinensis* (L.) Osbeck), located in Eastern Sicily, southern Italy, characterized by the presence of crop heterogeneity features within the same plant framework, both in terms of variety and age (i.e. 3-year old Tarocco Ippolito and 8 year-old Tarocco Nucellare Scirè, respectively).

The time-lapse ERI monitoring has permitted to identify specific wetting fronts and root water uptake (RWU) patterns effective in the soil / root system during dynamic condition (i.e. an irrigation cycle), mostly affected by the complex nonlinear interactions (i.e., soil evaporation, RWU and soil water redistribution) operating under crop heterogeneous conditions. Moreover, the use of soil moisture sensors installed *in situ* has permitted to identify a clear relationship between the changes in the soil water content observed in the field and the soil electrical resistivity (ER) characteristics with reference to the different types of analysed tree crops (with overall R^2 value of 0.63). Specifically, it has been observed that the soil evaporative process, represented by an increasing of ER values, was greater in the younger citrus trees due to their lower vegetation groundcover and roots development. While, the greater soil moisture changes (resulting in greater ER decreasing patterns) occurred for the mature tree crops, characterized by higher root biomass, because its initial soil water condition was lower in comparison to the young tree crops.