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Electrical Resistivity Tomography (ERT) to assess the drip irrigation water in a field cultivated with melon

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Characterization of agricultural soils using geophysical techniques makes it possible to study the heterogeneity of a soil and the preferential pathways of water flows without causing disturbances to soil and plants. Increased knowledge of soil heterogeneity allows the most optimal management of the water resource in terms of crop, yield and sustainability. In this study, time lapse monitoring, using electrical resistivity tomography (ERT), is proposed as a reliable and non-invasive technique to quantify the movement of water flows during the irrigation process.

ERT surveys were conducted in melon cultivated land in southern Tuscany (Italy). Four survey campaigns were carried out between June and August 2022, in which ERT data were collected by taking measurements, before, during, and after the irrigation phase. The investigation was conducted with a 3-D grid in which the 72 electrodes were spaced 0.3 m apart and arranged in three parallel lines, 0.3 m apart and 6.9 m long, for a total of 24 electrodes in each line. The plants were located above a ridge having a height of 20 cm with respect to the ground level and the electrodes were positioned to incorporate 5 melon plants in the configuration. A dipole-dipole configuration was adopted for the acquisition of electrical resistivity data. Commercial ViewLab 3D software was used to process the geoelectrical data.

The interpretation of the ERT results provided information on the spatial and temporal distribution of water flows in the soil and in the root zone of melons during the irrigation phases. The investigation made it possible to identify the preferential ways of infiltration of the irrigation water, the points where the water is absorbed by the roots, and the points where the water instead follows a preferential way distributing itself entirely below the area of root growth. During the investigations, the irrigation time underwent changes dictated by the climatic conditions, therefore the irrigation time and frequency were increased. This manifested itself in the ERT sections with an increase in the conductivity below the roots, i.e., at a depth of about 35 - 40 cm with respect to the ground level. This phenomenon can be explained by the fact that over time the water has developed a greater preferential path, completely bypassed the root system and collected below it, in the zone delimiting the worked soil with the unworked soil.

In the present case study, the ERT technique proved to be a valid survey and monitoring method for mapping the preferential paths of water flows in agricultural land. The ERT sections made it

possible to study the distribution of water along the soil profile, highlighting the presence of preferential paths that produce an accumulation of water below the root zone and therefore in an area that is not very usable for cultivation. This technique can therefore be used in this context to study a better irrigation system and an optimal management of the water resource, avoiding preferential paths of the flows which lead to a lower availability of water for the plant.