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# Assessing root water uptake transit time by simulating isotope transport in Hydrus-1D

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Stable isotopes ($^{2}H$ and $^{18}O$) are common natural tracers for the investigation of water transport in the soil-plant-atmosphere continuum. Isotopic data can be coupled with soil water content data to inversely estimate soil hydraulic and transport parameters. The calibration of a hydrological model by inverse modelling is a prerequisite to determine the temporal origin of xylem water taken by roots.

In this study, we used isotopic data to calibrate Hydrus-1D via inverse modelling to simulate one-dimensional water flow and isotope transport in a controlled soil-plant-atmosphere system. We propose the following protocol i) to estimate root water uptake transit time of irrigation water, and ii) to assess the sensitivity of the transit time distribution to the variation in the water available for root uptake.

The dataset was obtained from an isotope-tracing experiment carried out between May and July 2018 on an olive tree placed in a pot inside a glasshouse. Meteorological variables and sap flow were monitored at 5-minute intervals, whereas shallow soil moisture (0-6 cm depth) was measured manually with an impedance probe at the daily timescale. The olive tree was irrigated with water of known isotopic composition. The pot surface was covered by a plastic sheet to avoid evaporation. Soil at different depths, twigs, wood cores and root samples were collected weekly for isotopic analyses. Water from soil and the xylem tissues was extracted by cryogenic vacuum distillation. Based on the results of a previous study carried out on the same dataset, we considered that no isotopic fractionation occurred during the water uptake and the transport within the olive tree.

We used soil water content and $\delta^{18}O$ data at different soil depths to optimize flow (soil hydraulic and root water uptake parameters) and transport (longitudinal dispersivity) parameters. Numerical simulations of isotope transport were validated with sap flow data (compared to actual transpiration) and $\delta^{18}O$ in xylem water. Given that the timing of irrigation water for plant transpiration is fundamental for assessing the vulnerability of olive trees to drought, we will be proposing various scenarios based on different irrigation events to mimic drought periods. Based on these scenarios, we will be evaluating the sensitivity of the root water uptake transit time to the different water availability in the soil profile. Afterwards, the same protocol will be exploited to

determine the root water uptake transit time for different tree species under various environmental conditions.

Keywords: stable isotopes, HYDRUS-1D, root water uptake, transit time, soil water.

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