EGU2020-13382
https://doi.org/10.5194/egusphere-egu2020-13382
EGU General Assembly 2020

Estimating irrigation contribution to apple tree water uptake by deuterium tracing

Agnese Aguzzoni, Michael Engel, Damiano Zanotelli, Francesco Comiti, and Massimo Tagliavini
Free University of Bozen-Bolzano, Faculty of Science and Technology, Italy

Against the background of a future decrease in water availability, there is a need to use irrigation water with higher efficiency. To improve water management, it is crucial to clarify the role of irrigation water compared to soil water and additional water sources, including groundwater, which is often neglected by most water balance models.

We used deuterium-enriched water as tracer to distinguish irrigation water from soil water and groundwater and evaluate its contribution to the apple tree water uptake. The study was conducted in an apple orchard (Malus domestica, cv. Pinova) located in a flat area of the Venosta valley (South Tyrol, Italy) characterized by shallow groundwater (about 0.9 m from the ground). Before the experiment, the soil was covered for two weeks to prevent rain and irrigation from entering the soil. In July 2019, deuterium-enriched water (40 L/m^2, δ^2H = 1500 ‰) was homogenously applied to the soil in four plots. In the proximity of each irrigated plot, not-irrigated trees were present (controls). From both irrigated and control plots, soil, leaf and shoot axis samples were collected starting from 2 hours until 7 days after the irrigation. Total tree and soil water was extracted through cryogenic vacuum distillation. Soil and plant water isotope composition was measured at the IRIS (Isotope Ratio Infrared Spectroscopy) and at the IRMS (Isotope Ratio Mass Spectrometry) analyzer, respectively. Reference ET for the period was 3.3 mm day^{-1} on average.

Soil moisture in both irrigated and control soils decreased from the surface to 0.4-0.5 m soil depth and then progressively increased again until 0.8 m depth, in line with a maximum capillary rise of approximately 0.4 m estimated by models for a silty loam soil. In the upper 0.5 m soil layer, where around 80 % of total fine roots were concentrated, labeled irrigation water represented ca. 20 % of total soil water. The labeled water firstly appeared in the shoots starting from 8 hours from the irrigation (average δ^2H = 27.4 ‰) and the deuterium concentration reached its maximum after 24-48 hours from water supply (δ^2H = 68.1 ‰). At this time, irrigation water accounted for 8 % of the shoot extracted water. Considering the average deuterium abundance of the extracted water in the first 0.5 m soil layer, where labeled irrigation water mixed with soil water, we estimated that 35-40 % of the shoot water had been absorbed from such a layer. These preliminary results highlight the complexity of soil-water-plant interactions and call for additional investigation to understand the role of the soil water present before irrigation that could be preferentially taken up by roots. Additionally, the contribution of an upward flux from groundwater should be

quantified.