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Assessment of the root distribution and root water uptake pattern of a pear tree

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Pear growing (Pyrus Communis c.v. ‘Conference’) is an important part of horticulture in Belgium and the Netherlands. Drip irrigation techniques are increasingly used to achieve maximal production with a high fruit size distribution. Drip irrigation and the fact that trees are planted in rows alternated with grass strips causes a heterogeneous water distribution in the soil profile of the orchards beneath the trees. To schedule the irrigation, fruit growers use soil water sensors, as for example the Watermark sensor, which are point measurement of the soil water tension in the soil profile. To use these tools correctly, more knowledge about the water extraction pattern of the tree can improve current techniques for irrigation scheduling. Also the impact of root pruning, a management technique to control the vegetative vigour of the pear tree, on the water availability can be estimated when the water extraction pattern is determined.

In a pear orchard near the city of Sint-Truiden, Belgium, the evolution of the soil water tension was monitored by ten different Watermark sensors around one tree installed at different depths. The orchard was situated on a silt soil and was composed of 11 year old pear trees cv. ’Conference’ on Quince Adams rootstock. After the growing season the root distribution of the tree was measured. The distribution of the coarse roots (diameter > 2 mm) was measured after excavation; the distribution of the fine roots was obtained after the sampling of soil cores and washing out the roots through a 1-mm sieve. Transpiration of the tree was calculated based on reference evapotranspiration and compared to sap flow measurements on the stem of tree. The drip irrigation system was installed at twenty cm at one side of the trunk. This way one part of the root zone remained moist while the soil water tension reached -70 kPa on the other part of the root zone.

Simulations were performed with the HYDRUS 3D model. Comparison between the model output and the Watermark measurements led to an estimation of the sink term for root water uptake in the Richards Equation which describes water movement in the unsaturated zone. In the sink term the root distribution was implemented based on the distribution of the fine roots, which was related to the distribution of the coarse roots. Also the effect of compensation, whereby the tree roots take up more water in the humid parts of the root zone, was estimated. With the final model description, the impact of root pruning was simulated. The results illustrate that the majority of the root water uptake occurs in the upper soil layer and proves that root pruning causes faster root zone depletion. Finally, this will result in improved guidelines for irrigation scheduling in orchards with the aid of soil moisture sensors.