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"Development on the margin"

Root Functional Architecture: Modelling the Root Zone Dynamics of Water Uptake by Trees

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Abstract

Root architecture plays a major part in determining a root system's ability to function effectively and efficiently in its essential roles of anchorage and the capture of soil resources. The characteristics of root development that are conventionally considered to be the main determinants of root architecture are the rate, angle, and duration of root growth and the pattern of root branching. Water uptake by plant roots is a main process controlling water balance in field profiles and is vital for agro-ecosystem management. We report the results from a field experiment in which we examined the spatial and temporal patterns of water uptake by trees in an orchard. Time Domain Reflectometry (TDR) was used to measure changes in the soil volumetric water content, and lysimeter was used to monitor drainage and evapotranspiration in the soil. The 2D depth- and radial-wise distribution of roots was determined from the average root-length density of the same sample within the root zone.

In this contribution we examine variations in soil physical, chemical, and biological properties and their impact on root growth. Finally, we describe how the concept of root functional architecture can improve the integration of research advances from fields operating as independent disciplines and improve our understanding of soil ecosystems.

When the surface soil layers were uniformly wet, 80 % of the trees water uptake occurred in the top 0.47 m of the root zone, in which approximately 80 % of the tree's roots were located. This study highlights the importance of root distribution and pattern in regulating soil water use and thereby improving endurance of plants to seasonal droughts for sustainable agricultural productivity.

Keywords: Environmental effect, root architecture, TDR, water uptake

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