Geophysical Research Abstracts
Vol. 15, EGU2013-13123, 2013
EGU General Assembly 2013

Spatiotemporal Pattern of Root Water Uptake for Locally Differing Soil Water Availability

Abbas Dara (1), Ahmad B. Moradi (2), and Sascha Oswald (1)

(1) Institute of Earth and Environmental Science, University of Potsdam, Germany, (2) Department of Land, Air and Water Resources University of California Davis, USA

One of the important but not well known questions is how the root system of a plant respond to water scarcity, especially if there is a locally heterogeneous distribution of soil moisture or accessibility of water. However, heterogeneous water availability is a typical characteristic of soils, for example by heterogeneity of soil properties, infiltration and evaporation or competition between plant roots. On top of that, water content in soil has a large temporal dynamics. Despite these intrinsic heterogeneities of soil-plant water relations, we know little about the ways how plants respond to local environmental properties. Recently imaging and tomography methods have become available, that facilitate the measurement of spatial and temporal distribution of water content and of the root system itself, which offers the possibility to investigate also the distribution of water uptake in a plant root system.

To monitor root water uptake response to local soil water availability, we used neutron radiography especially suited to detect water distribution, to non-invasively image root growth and 2-D soil water distribution as time-lapsed images. We applied a method to hydraulically partition the soil to be able to actively control the level of water available locally and at the same time to locally quantify water uptake for these heterogeneous conditions. The key results for an imaging experiment running full three weeks show topological patterns of water uptake along the root system. Moreover, under water stress, compensatory root water uptake maximizes soil water utilization in response to transpiration demand.
Lupin plants were grown in 40*35*1 cm^3 aluminum containers. The root zone was partitioned into twenty compartments separated by capillary barriers and divides the root system into taproot and lateral roots, and into young and old later root segments at the top, middle and bottom profile positions. Three weeks after planting, four soil-water treatments in three replaces each, were applied as: no stress (control), %50 stress (water available for 50% of the lateral roots) and 75% stress (water available for 25% of lateral roots in old and young parts in two individual treatments). Two levels of transpiration demand in 5-day periods each were also applied, interrupted by five days of recovering in between. Daily changes in soil water content and root water uptake rate in each compartment have been monitored by neutron radiography four times a day as well as daily transpiration rates.
The results show a high compensatory water uptake by the root segments in the wet parts under water stress. This root compensation increases significantly with increasing portion of the root system suffering water scarcity. ; While for low transpiration demand, there was not a significant difference in transpiration rate between 50% and 25% local water availability, for higher transpiration demand transpiration demand cannot be fully compensated when water is provided for the root system locally. In respect to root topology , root segments in the top with less distance to the shoot show higher rates of water uptake then those in the lower position while the difference in local root water uptake between old and young roots is not that high.