Geophysical Research Abstracts
Vol. 19, EGU2017-10165-1, 2017
EGU General Assembly 2017

Engineering rhizosphere hydraulics: pathways to improve plant adaptation to drought

Mutez Ahmed (1), Mohsen Zarebanadkouki (1), Katayoun Ahmadi (1), Eva Kroener (2), Stanley Kostka (3), and Andrea Carminati (1)

(1) Division of Soil Hydrology, Georg-August University of Göttingen, Göttingen, Germany (mahmed@gwdg.de), (2) Institute for Environmental Sciences, University of Koblenz-Landau, Landau, Germany, (3) Aquatrols Corporation of America, Paulsboro, New Jersey, United States

Developing new technologies to optimize the use of water in irrigated croplands is of increasing importance. Recent studies have drawn attention to the role of mucilage in shaping rhizosphere hydraulic properties and regulating root water uptake. During drying mucilage keeps the rhizosphere wet and conductive, but upon drying it turns hydrophobic limiting root water uptake. Here we introduced the concept of rhizoligands, defined as additives that 1) rewet the rhizosphere and 2) reduce mucilage swelling hereby reducing the rhizosphere conductivity. We then tested its effect on rhizosphere water dynamics and transpiration.
The following experiments were carried out to test if selected surfactants behave as a rhizoligand. We used neutron radiography to monitor water redistribution in the rhizosphere of lupine and maize irrigated with water and rhizoligand solution. In a parallel experiment, we tested the effect of rhizoligand on the transpiration rate of lupine and maize subjected to repeated drying and wetting cycles. We also measured the effect of rhizoligand on the maximum swelling of mucilage and the saturated hydraulic conductivity of soil mixed with various mucilage concentrations. The results were then simulated using a root water uptake model.
Rhizoligand treatment quickly and uniformly rewetted the rhizosphere of maize and lupine. Interestingly, rhizoligand also reduced transpiration during drying/wetting cycles. Evaporation from the bare soil was of minor importance. Our hypothesis is that the reduction in transpiration was triggered by the interaction between rhizoligand and mucilage exuded by roots. This hypothesis is supported by the fact that rhizoligand reduced the maximum swelling of mucilage, increased its viscosity, and decreased the hydraulic conductivity of soil-mucilage mixtures. The reduced conductivity of the rhizosphere induced a moderate stress to the plants reducing transpiration. Simulation with a reduced hydraulic conductivity of the rhizosphere reproduced well the experimental observations.
Rhizoligands increase the rhizosphere wetting kinetics and decrease the maximum swelling of mucilage. As a consequence, root rehydration upon irrigation is faster, a larger volume of water is available to the plant and this water is used more slowly. This slower water consumption would allow the plant to stay turgid over a prolonged dying period. We propose that by managing the hydraulic properties of the rhizosphere, we can improve plants adaptation to drought.