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From experiments to simulations: tracing Na+ distribution around roots under different transpiration rates and salinity levels

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When salinity increases beyond a certain threshold it will result in reduced crop yield at a fixed rate, according to Maas and Hoffman model (1976). Thus, there is a great importance of predicting salinization and its impact on crops. Current models do not consider the impact of environmental conditions on plants salt tolerance, even though these conditions are affecting plant water uptake and therefore salt accumulation around the roots. Different factors, such as transpiration rates, can influence the plant sensitivity to salinity by influencing salt concentrations around the roots. Better parametrization of a model can help improving predicting the real effects of salinity on crop growth and yield. The aim of this research is to study Na+ distribution around roots at different scales using different non-invasive methods, and study how this distribution is being affected by transpiration rate and plant water uptake. Results from tomato plants growing on Rhizoslides (capillary paper growth system), show that Na+ concentration is higher at the root- substrate interface, compared with the bulk. Also, Na+ accumulation around the roots decreased under low transpiration rate, which is supporting our hypothesis. Additionally, Rhizoslides enable to study roots' growth rate and architecture under different salinity levels. Root system architecture was retrieved from photos taken during the experiment and enabled us to incorporate real root systems into a simulation. To observe the correlation of root system architectures and Na+ distribution in three dimensions, we used magnetic resonance imaging (MRI). MRI provides fine resolution of Na+ accumulation around a single root without disturbing the root system. With time, Na+ was accumulating only where roots were found in the soil and later on around specific roots. These data are being used for model calibration, which is expected to predict root water uptake in saline soils for different climatic conditions and different soil water availabilities.