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Changes of water content in a ricinus root system monitored by magnetic resonance imaging

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The purpose of this study is to investigate how the water content change caused by root water uptake may be mapped non-invasively in 3 dimensions by magnetic resonance imaging (MRI). For that purpose a four week old ricinus root system was planted in an artificial soil (99.5% fine sand, 0.5% clay), initially saturated with $^1/_2$ hoagland nutrient solution and finally sealed so that transpiration could take place only through the leaves and the change of water content was only caused by root water uptake. Water content was monitored by the SPRITE measuring sequence at four different dates 1, 12, 15, and 20 days after implantation. The SPRITE signal I(t_p) which probes the T_2^*relaxation was recorded between t_p = 0.08 to 4.0 ms with an isotropic spatial resolution of 6.3 mm, and the amplitudes were extrapolated by fitting exponential functions to the I(t_p) curves. Next the amplitudes were calibrated by a 99% water standard yielding the 3D water content distribution in the soil. Finally, the reliability of the technique and the evaluation procedure was proven by the linear correlation of the soil-volume integrated amplitude with the gravimetric water content.

A parallel study of the root architecture was performed by the CISS sequence with a high resolution (0.6 mm) for coregistration of the water content changes with the root architecture. Since water in the root tissue relaxes slower than in the surrounding soil a good contrast was given even at short echo times of about 3 ms and allowed a detailed imaging of the roots. Finally, the combination of both types of imaging (water content and architecture) indicates that the most drastic changes of water content took place in the region of the root tips.