Improved non-invasive root detection in soil using low noise magnetic resonance images

Daniel Pflugfelder*, Robert Koller, Dagmar van Dusschoten*

Institute of Bio- and Geosciences, IBG 2: Plant Sciences, Forschungszentrum Jülich, 52425 Jülich, Germany

ORCiD: [0000-0001-6187-2935]

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Using magnetic resonance imaging (MRI), our established root phenotyping platform (van Dusschoten et al., 2016) can visualize and analyze plant roots in natural soil nondestructively (Pflugfelder et al., 2017). Using plant pots with 9 cm diameter and 30cm height, a root system can be scanned within 1h while roots down to diameters of 300µm can be detected and analyzed using our in-house root extraction software NMRooting (van Dusschoten et al., 2016). Thanks to automation with a pick-and-place robot the platform routinely achieves a throughput of 24 plants per day.

All these values, however, are based on compromises between imaging speed and quality. In our system, the root detection limit is determined by the signal to noise ratio (SNR) of our images. The SNR can be increased by using smaller plant pots or by increasing the imaging time. In this contribution we investigate the potential gain in the root detection limit when sacrificing plant throughput in favor of image quality. We acquired low noise root images using repeated signal averaging during the measurement process. Using this approach, the root detection limit could be lowered, visualizing roots not detected by the standard imaging protocol.

Literature:

van Dusschoten, D. et al. (2016) 'Quantitative 3D Analysis of Plant Roots growing in Soil using Magnetic Resonance Imaging', Plant Physiology, 170(3), pp. 1176–1188. Available at: https://doi.org/10.1104/pp.15.01388.

Pflugfelder, D. et al. (2017) 'Non-invasive imaging of plant roots in different soils using magnetic resonance imaging (MRI)', Plant Methods, 13(1), p. 102. Available at: https://doi.org/10.1186/s13007-017-0252-9.