Noninvasive 3D Root Imaging

IBG-2: Plant Sciences, Forschungszentrum Jülich

Goals:
- Noninvasive imaging of 3D root system architecture (RSA) and function in natural soil
- Identification of structural and functional root system traits
- Monitoring the development of root system traits during plant growth and identifying traits of resource use efficient roots

Magnetic Resonance Imaging (MRI)

Project status
- Dedicated 4.7T plant MRI [1]
- High contrast 3D root images due to suppressed soil signal
- Automated measurements with a prototypic robot system
- MRI data analysis software to:
  - Extract RSA automatically
  - Manually correct obtained RSA
  - Calculate traits from RSA

Next steps:
- Measurement series on a variety of species/genotypes/treatments → see Poster:
- Improve automated extraction of RSA
- Setup of an image database infrastructure

Results: Data extraction from MRI images

Selective traits obtained from shown MRI data:

<table>
<thead>
<tr>
<th>Days after sowing</th>
<th>Number of Roots</th>
<th>Fresh weight (g)</th>
<th>Total root length (mm)</th>
<th>Primary root length (mm)</th>
<th>Lateral root length (mm)</th>
<th>Mean lateral length (mm)</th>
</tr>
</thead>
<tbody>
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<td>208</td>
<td>33</td>
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<td>79</td>
<td>0.49</td>
<td>1380</td>
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<td>1055</td>
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<tr>
<td>10</td>
<td>113</td>
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</tr>
</tbody>
</table>

Comparison of root diameter estimates obtained by MRI and WinRhizo:

Positron Emission Tomography (PET)

Project status
- First tracer experiments with an existing, but rather insensitive PET system (PlanTIS [1])
- New plant dedicated, highly sensitive PET system (phenoPET) currently been assembled
- First test measurements acquired

Next steps:
- Finish buildup and testing of phenoPET system
- Development of quantitative image reconstruction for improved monitoring of tracer transport parameters
- Development of systems to facilitate automated combined MRI-PET measurements

Results: Fused MRI/PET images

Sugar beet, 110 DAS
Maize root, 11 DAS
Grayscale: MRI data
Color: PET image showing 13C tracer distribution. For quantification of tracer transport, see [2]


This work was performed within the German-Plant-Phenotyping Network which is funded by the German Federal Ministry of Education and Research project identification number: 031A053.