Carbon dynamics in nodulated pea root systems: 3D imaging and quantification with short lived isotopes

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In natural ecosystems and low-input agriculture systems often the main source of nitrogen is biological nitrogen fixation by symbiotic coexistence with root colonizing microorganisms such as in root nodules in legumes. In return for this nutrient supply, plants allocate significant amount of photosynthetically fixed carbon (C) belowground, fueling activity and growth of the nodules. However, there is still a lack in understanding how plants modulate carbon allocation to a nodulated root system as a dynamic response to abiotic stimuli. Traditional approaches based on destructive sampling make investigations of localized carbon allocation dynamics difficult. Non-destructive 3D-imaging methods including Magnetic Resonance Imaging (MRI) and Positron Emission Tomography (PET) offers new perspective in analysing belowground processes on individual plants. MRI allows for repetitive measurements and quantification of root system architecture traits nodule structures while growing. PET was employed to follow the spatial distribution of leaf-supplied ^{11}C tracer to nodules and roots.

Using *Pisum sativum* as model for legumes and applying nitrate as an additional N source we investigated short term C allocation dynamics in the root system. We found that the fraction of ^{11}C tracer arriving in the most active nodules decreased by almost 40% and remained stable between 16h and 42h after the N application.

Our results highlight that the combination of MRI-PET enables deeper insights into short term C dynamics of roots and interactions with colonizing microbes. We expect that this modality has

high potential for revealing mechanisms that relate to dynamic fitness traits supporting breeding programs for future crops.