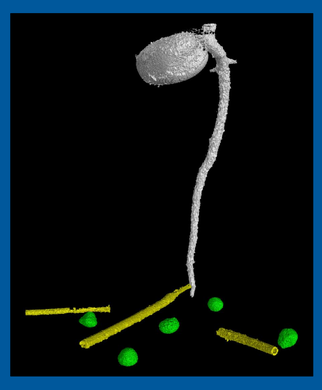

Influence of different urea-based fertilizer granules in soil on root system development, soil chemistry and plant growth under controlled conditions

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1 Introduction and Background

- **Urea** is the most widely used nitrogen (N) fertilizer worldwide and undergoes rapid hydrolization in soil, after which the **ammonia is oxidized to nitrate**.
- Due to the use of **nitrification inhibitors**, the importance of **NH_4^+ as N source** has increased.
- Nitrogen is heterogeneously distributed in the soil matrix and fertilizer application can create **nutrient patches**, e.g. by the usage of urea granules.
- Two general ways of root response seem to be common including **systemic repression** of lateral root (LR) growth by **high N status** of the plant and **local stimulation/inhibition** of LR growth by availability of **NO_3 or NH_4** [1-8].
- These responses are controlled by **external & internal signals**, associated with local & systemic **signaling pathways** in the plant [2, 4, 6, 9, 10].

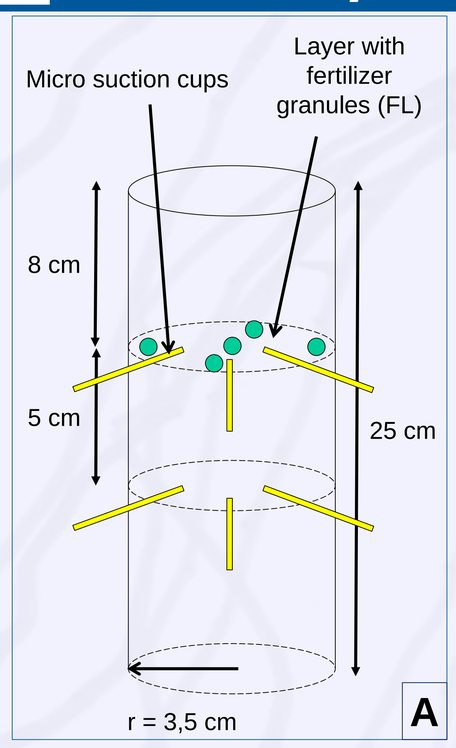
2 Aims

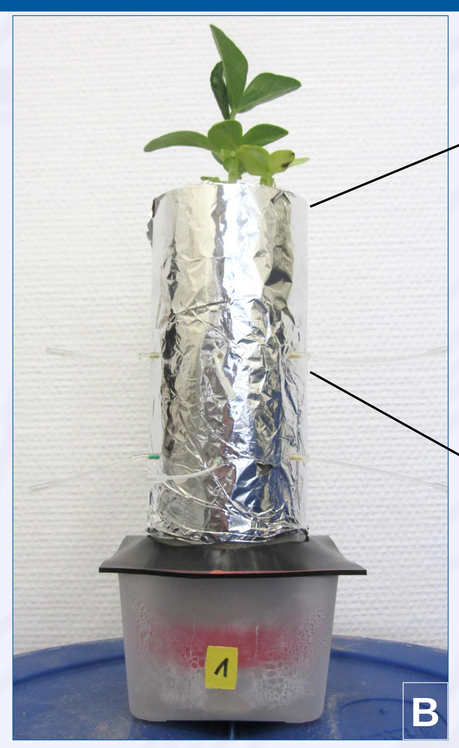
- **Combination** of *in situ* analysis of **root system development** in the soil with **soil chemical studies** (pH & N-dynamics in soil solution).
- Increase understanding of **temporal and spatial** dynamics of **root response** to **non-uniform** supply of N *in situ.*

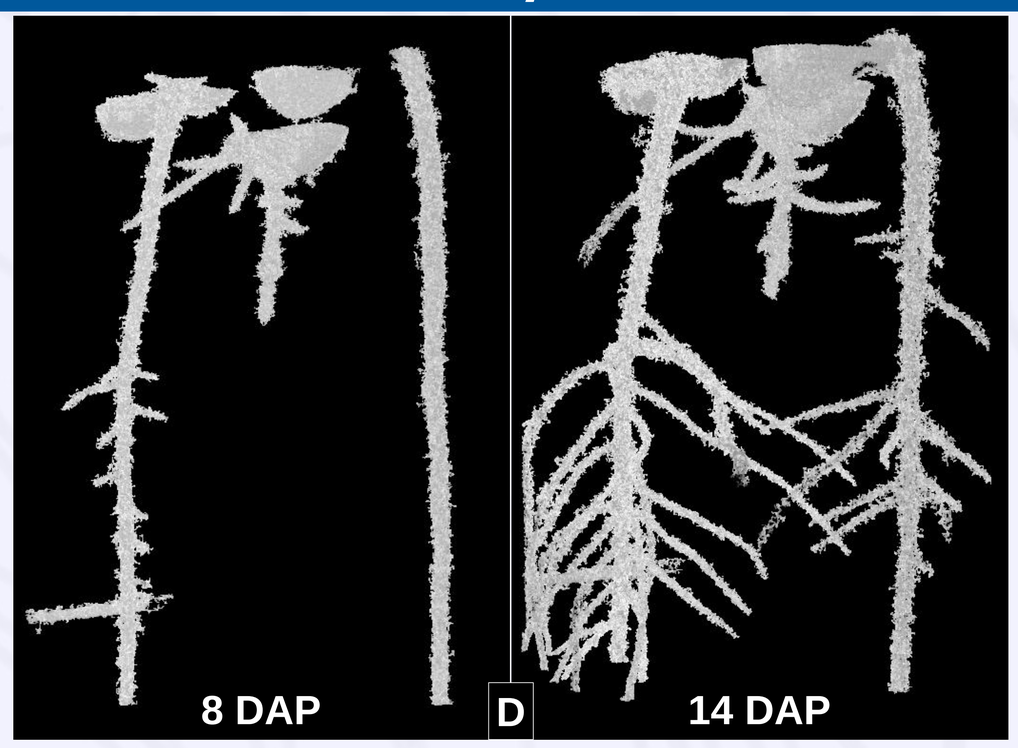
3 Methods

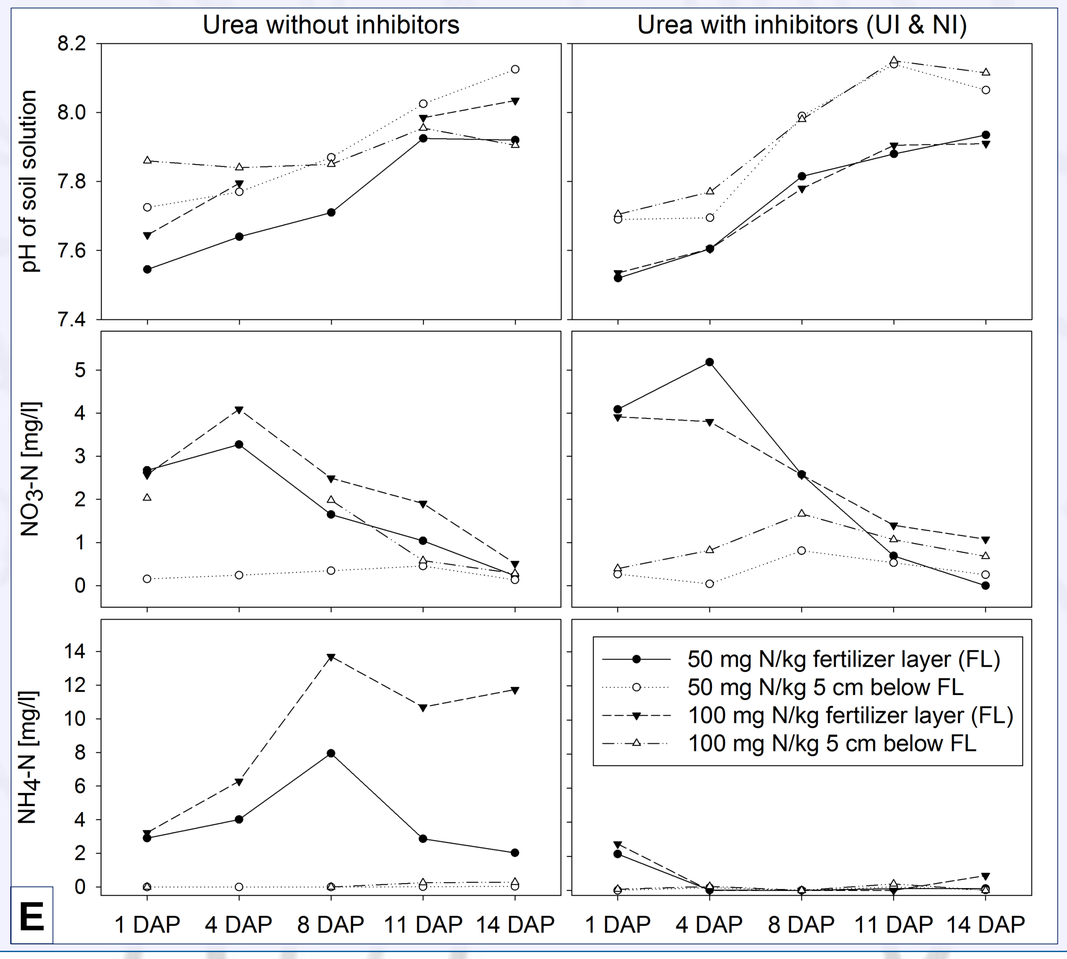
- Use of **urea** with and without **inhibitors** for urease (UI) and nitrification (NI) to create **different N regimes** (NO_3 / NH_4).
- **Visualization** and **characterization** of **root system development** *in situ* by X-ray CT [11, 12].
- Monitoring of **soil solution composition** with micro **suction cups**.
- Control of **root parameters** with WinRHIZO (Regent Instruments).

4 Preliminary results of new methodological approach (Blaser *et al.; unpublished data*)









A) Sketch of the sample setup with granulated urea-based fertilizer (green) and micro suction cups (yellow).
B) Sample setup with 3 plants of *Vicia faba*. Samples are watered from below and aluminum foil prevents algae growth.
C) Raw image from the upper part of a sample obtained by X-ray CT.
D) Exemplary results of X-ray CT: Roots of *Vicia faba* obtained by X-ray CT and segmented with a 'region growing' algorithm 8 and 14 days after planting (DAP).
E) Results of soil chemical analysis: Changes of pH, NO_3-N and NH_4-N in the soil solution of samples with N fertilizer in form of urea without inhibitors on the left and of urea with inhibitors (UI & NI) on the right.

5 Conclusions

- Pot size, growth conditions, X-ray CT scanning parameters and micro suction cup sampling intervals are now optimized to enable visualization of all roots, including laterals.
- Hence lateral root formation can now be analyzed with sufficient temporal resolution in the context of changing N-forms and quantities in soil solution.

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