

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].

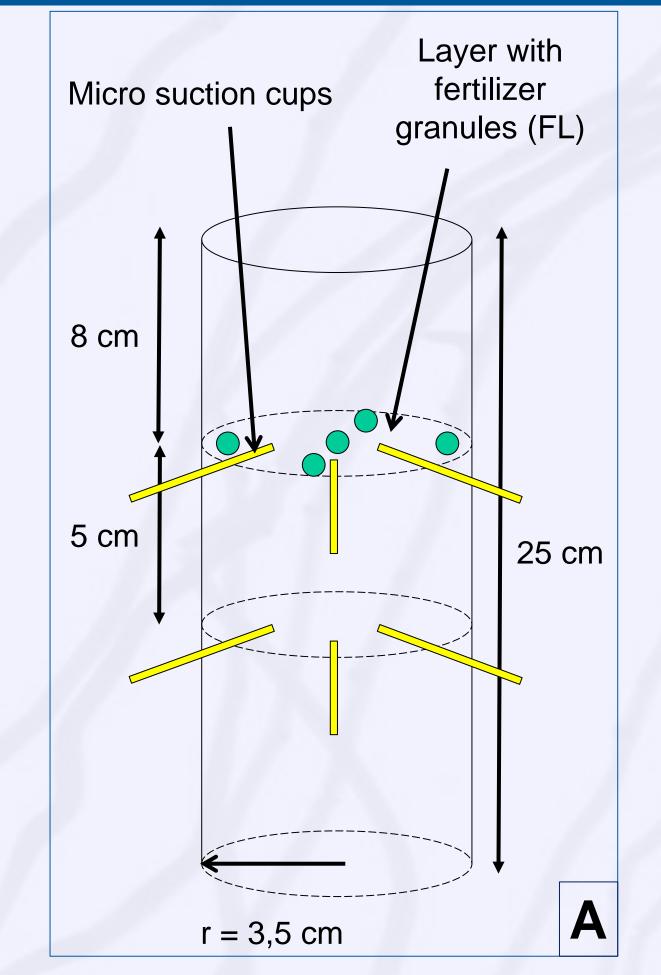
2 Aims

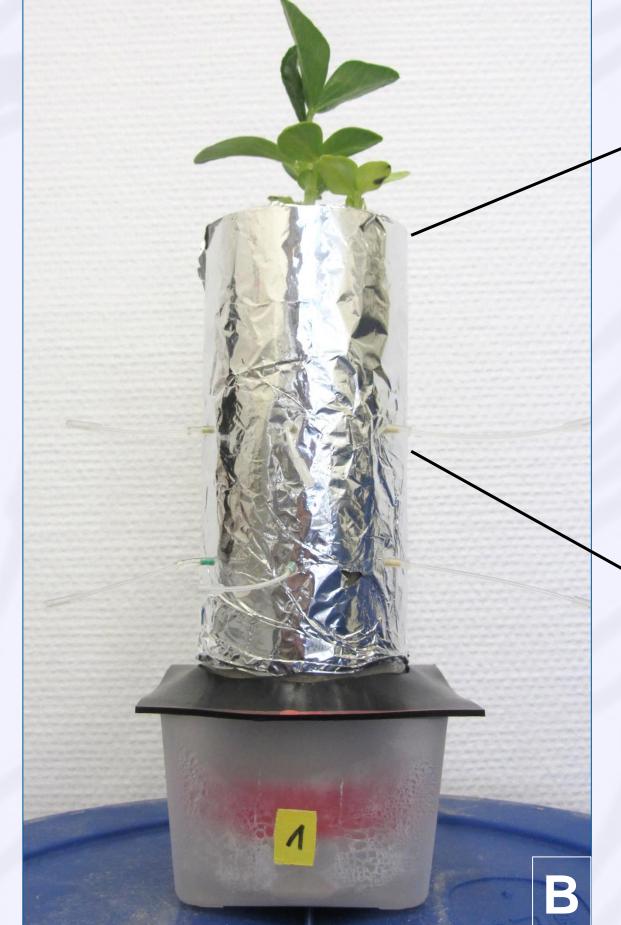
- Combination of in situ
 analysis of root system
 development in the soil
 with soil chemical studies
 (pH & N-dynamics in soil solution).
- Increase understanding of temporal and spatial dynamics of root response to non-uniform supply of N in situ.

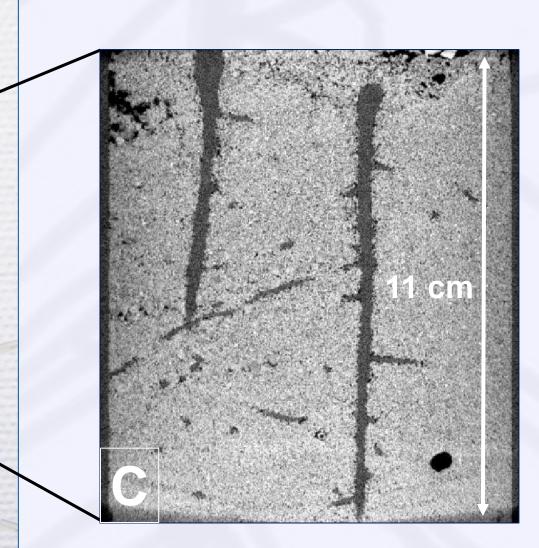
3 Methods

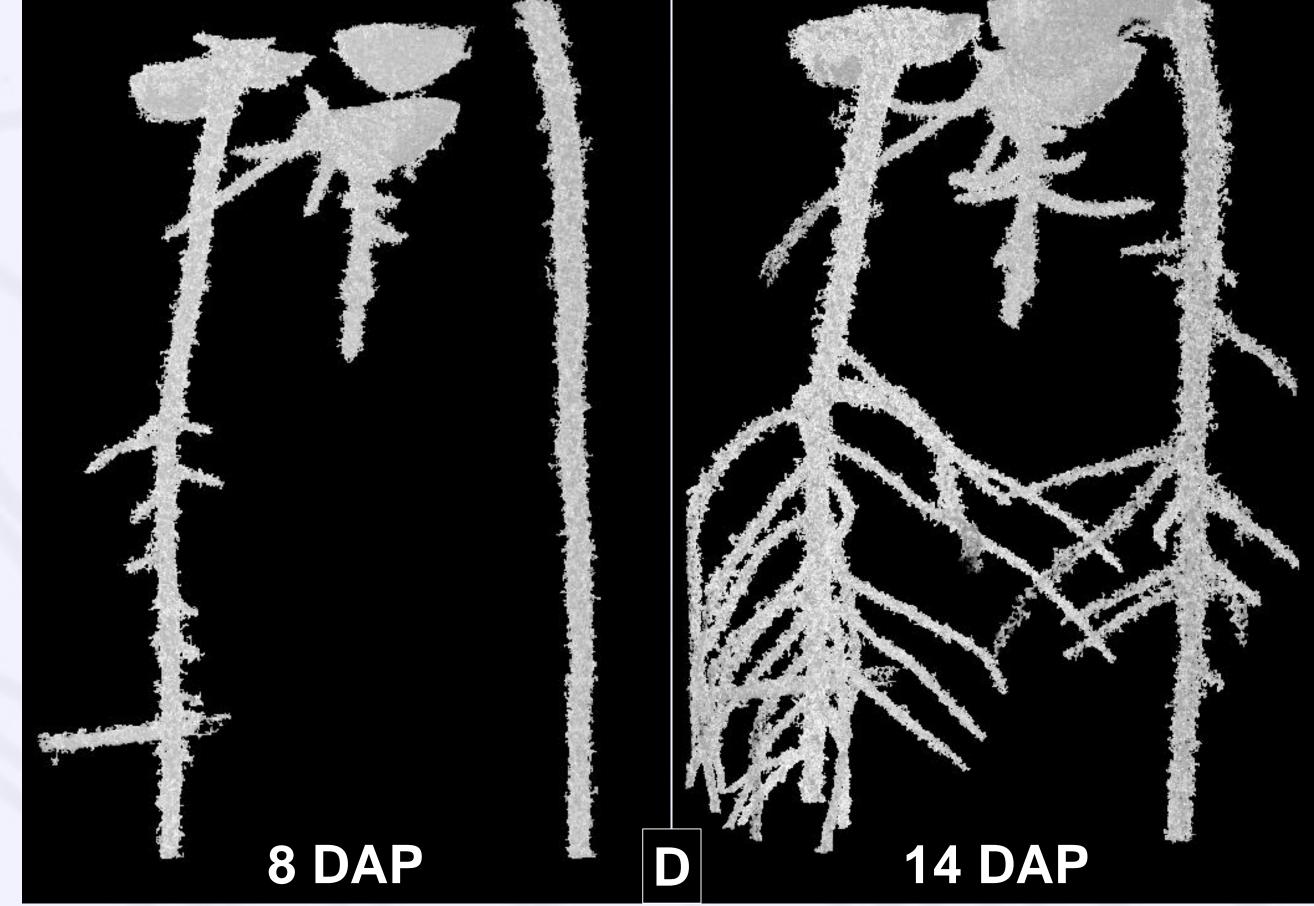
- Use of **urea** with and without **inhibitors** for urease (UI) and nitrification (NI) to create **different**N regimes (NO₃ / NH₄).
- Visualization and characterization of root system development in situ by X-ray CT [11, 12].
- Monitoring of soil solution composition with micro suction cups.
- Control of root parameters with WinRHIZO (Regent Instruments).

4 Preliminary results of new methodological approach (Blaser et al.; unpublished data)

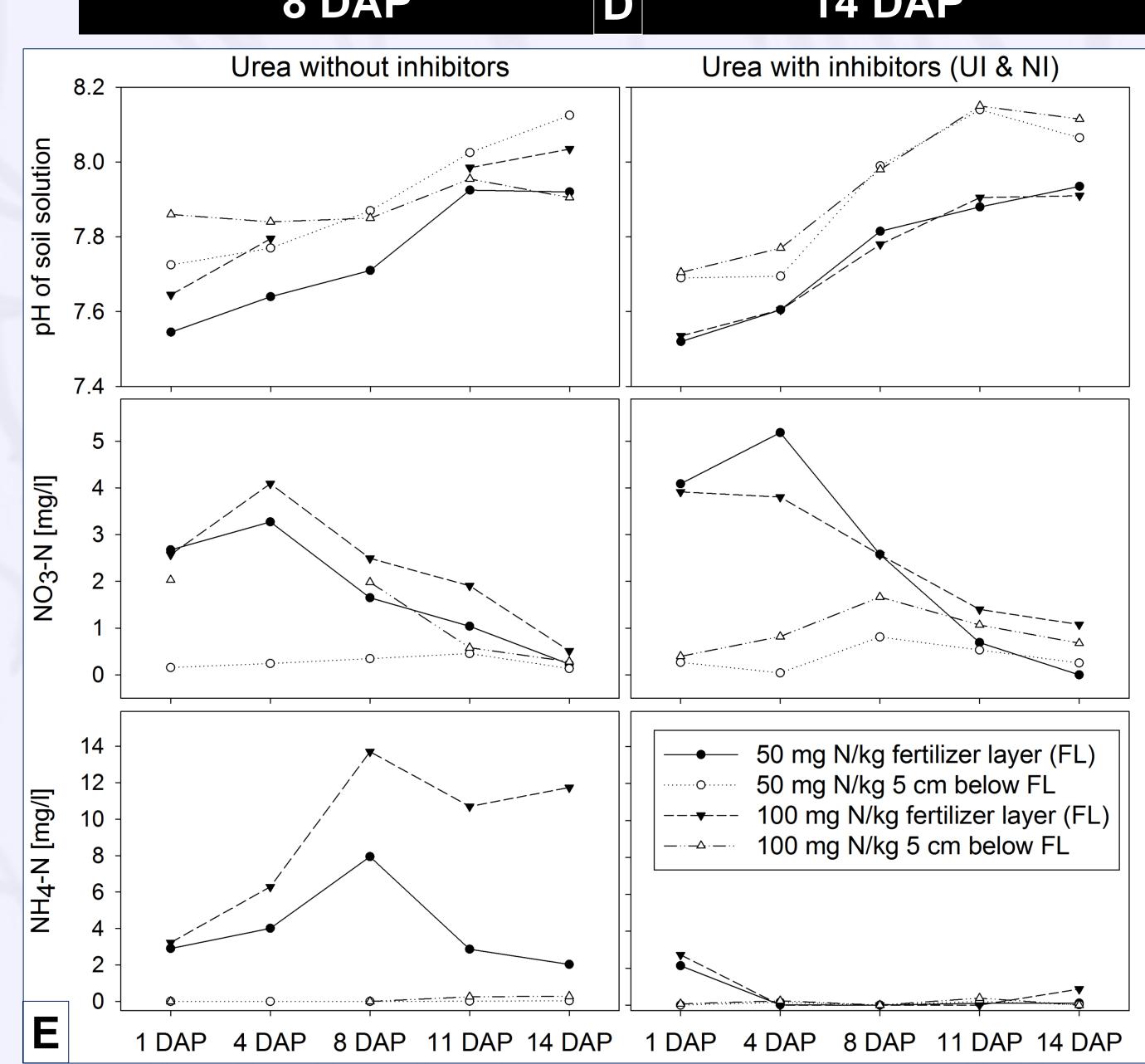








- A) Sketch of the sample setup with granulated urea-based fertilizer (green) and micro suction cups (yellow).
- B) Sample setup with 3 plants of *Vicia faba*. Samples are watered from below and aluminum foil prevents algae growth.
- C) Raw image from the upper part of a sample obtained by X-ray CT.
- 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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