Plant Exudate and Root Microbiota Dynamics during Pathogen Attack

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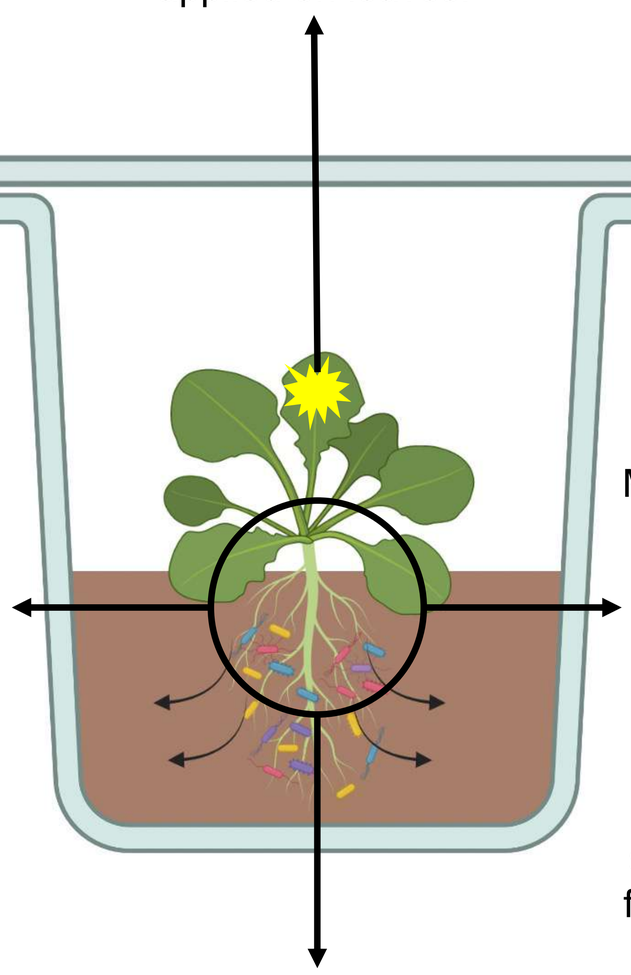
Summary

Upon pathogen attack, plants adjust the composition of their microbiome including recruiting beneficial strains with protective functions. However, the specific signals emitted to mediate the change in microbial community remain largely elusive (1). Plant roots secret a wide variety of compounds. These are believed to function, amongst others, as nutrients and signaling molecules to microbes (2).
Due to the complexity of soils and belowground associations, it poses a major technical challenge to study root exudate and root microbiota dynamics in parallel during pathogen attack. Using *Arabidopsis thaliana* as a model, we develop a sterile microcosm system that permits to simulate a pathogen attack and measure root exudation patterns as well as changes in associated microbial communities in response (Figure 1).

Study System

Simulation of pathogen attack
To avoid interference with the plant-microbe interactions, elicitors are applied on leaves.



High throughput root exudate profiling
Root exudates are measured with flow injection analysis mass spectrometry (FIA-MS).

Straight forward microbial community analysis
Microcosms are inoculated with a defined synthetic bacterial community (syncom) composed of strains isolated from *A. thaliana* roots

Defined substrate
To develop our study system we compare plants grown on a clay substrate or in a hydroponics system. While the clay substrate mimics soil conditions, including air-pockets and micro-niches for microbes to thrive, the hydroponics system ensures easy manipulation of roots and has been developed to monitor root exudation patterns in a time resolved manner.

Figure 1. Schematic representation of desired Microcsm system.

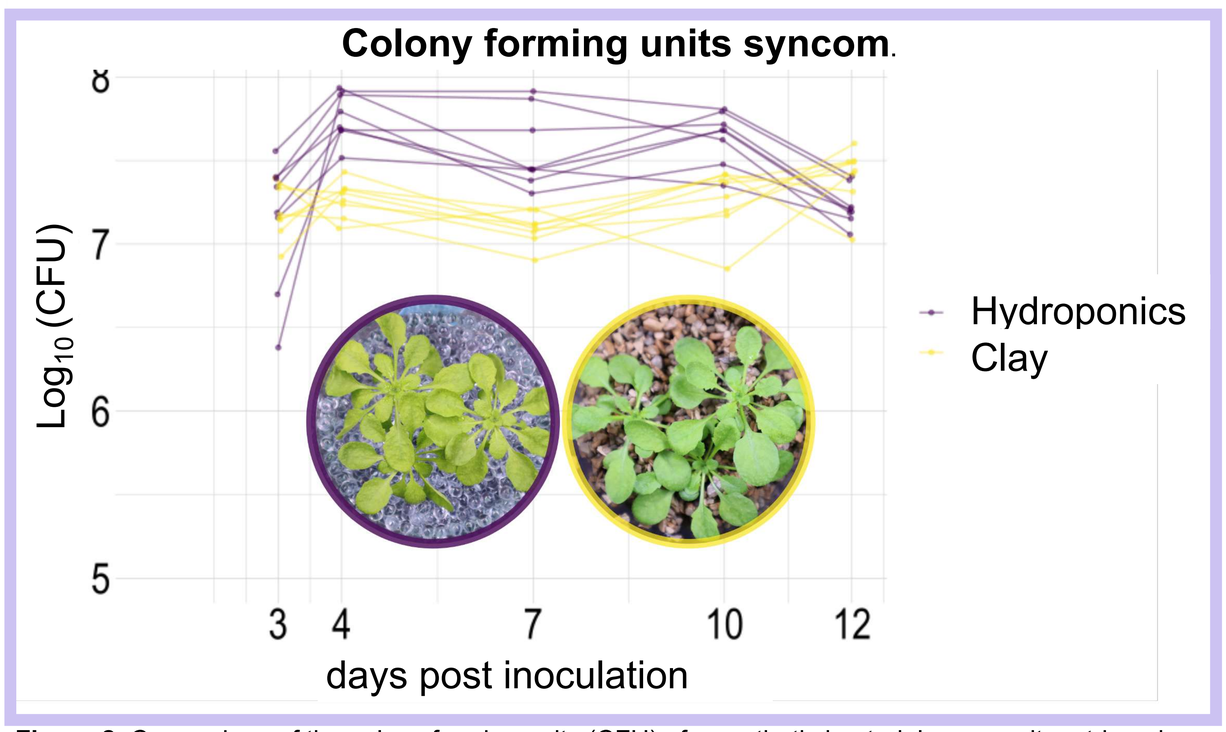


Figure 2. Comparison of the colony forming units (CFU) of a synthetic bacterial community retrieved from a clay and a hydroponics microcosm system at 3, 4, 7, 10 and 12 days post inoculation (dpi). Dots correspond to a singel measure and lines connect measures from the same replicate over time (N=8). Inlet pictures were taken at 12 dpi.

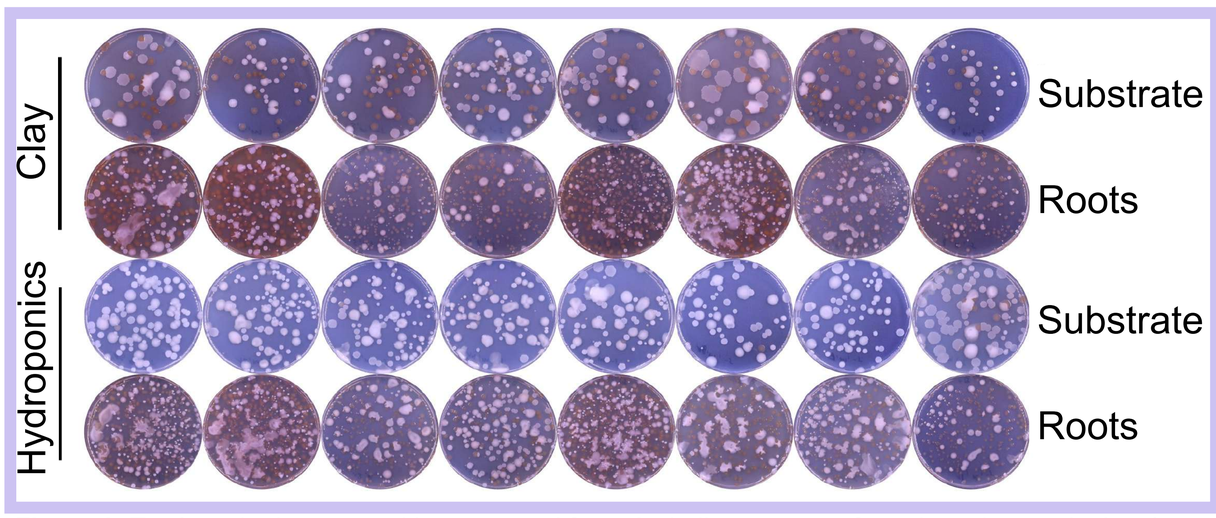


Figure 3. Total synthetic communities extracted from *A. thaliana* roots or from the substrate in the clay and hydroponics systems (N=8).

First results

Members of the synthetic community associate with *A. thaliana* roots in both clay- and hydroponics systems at comparable densities (Figure 2). Furthermore, a shift in microbial composition between growth medium and roots could visually be assessed in both systems, indicating a selection of specific microbes at the root interface (Figure 3).

Outlook

Next, we will determine the microbial community in the microcosm systems using 16S sequencing and/ or selective plating. Additionally, we will finetune elicitor application on leaves to get a robust immune signaling from shoot to root. Finally, knowing that clay will absorb many compounds, we want to assess if a clay-based microcosm system is suitable for root exudate sampling.

References:
1. Rolfe, Stephen A, Joseph Griffiths, and Jurriaan Ton. “Crying out for Help with Root Exudates: Adaptive Mechanisms by Which Stressed Plants Assemble Health-Promoting Soil Microbiomes.” *Current Opinion in Microbiology* 49 (June 2019): 73–82. https://doi.org/10.1016/j.mib.2019.10.003.
2. Vives-Peris, Vicente, Carlos de Ollas, Aurelio Gómez-Cadenas, and Rosa María Pérez-Clemente. “Root Exudates: From Plant to Rhizosphere and Beyond.” *Plant Cell Reports* 39, no. 1 (January 1, 2020): 3–17. https://doi.org/10.1007/s00299-019-02447-5.