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Compositional change of the phyllosphere due to secondary metabolite production

The plant rhizosphere is the culmination of all bacteria, and phages, that are present in the below ground tissues of plants starting at the base of the above ground plant material – the crown. These communities are comprised of harmful bacterial (such as pathogenic bacteria like *Agrobacterium tumefaciens*), neutral bacteria, and beneficial bacteria like Rhyzobia which are a symbiont for plants which form root nodules where they fix nitrogen and transfer it to the host plant in exchange for nutrients from the plant (1). While the root microbiome has an extensive list of research focused on the interactions within the rhizosphere, there is not much research looking at the interaction between the phyllosphere (the microbial community within the above ground plant material) and the rhizosphere.

elucidating the community composition and the interactions between the host-plant and the root microbiome, there is a surprising lack of research looking at the composition and interactions of the phyllosphere with its host plant.

Previous studies looking at the interactions between the host-plant and the root microbiota have given way to complex interactions where the host-plant (*Arabidopsis thailiana*) releases a defence compound called galactinol which is in-turn is utilized as a nutrient by the bacterial pathogen *Agrobacterium fabrum,* because of its ability to utilize galactinol as a source of sugar,thereforenegating its anti-microbial effectswhich allows it to resist the host-plant defence response (2). With this in mind, the next question to be asked is if the community of microbiome of the phyllosphere is affected by the release of the defence compound galactinol, and if there are effects on the composition of the Pseudomonas syrangae and Pseudomonas sp. (add the actual species I remember them).

microbiome of the phyllosphere.

The plant phyllosphere is the culmination of all bacteria, and phages, that are present in the above ground tissues of plants starting at the base of the above ground plant material – the crown. These communities are comprised of harmful bacterial (such as pathogenic bacteria like *Xanthomonas campestris*), neutral bacteria, and beneficial bacteria which aid the plant. Unlike the root microbiome, there are a lack of nitrogen fixing bacteria such as *Rhyzobia* (which is responsible for the root nodule formation on legumes), and other root microbiome specific bacteria, which cannot successfully grow on the upper portions of plants (1). While the root microbiome has an extensive list of research focused on elucidating the community composition and the interactions between the host-plant and the root microbiome, there is a surprising lack of research looking at the composition and interactions of the phyllosphere with its host plant.

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microbiome of the phyllosphere.

defence chemicals and to what extent .

As this is just one of the hundreds of defence chemicals released by the plant for defence there are many unexplored chemicals which may be utilized by organisms in the microbiome for their own use.

What this project wishes to investigate is to see the effects that defence compounds (such as Galactinol and Coronatine) have on the composition of the microbiome.

It is predicted that chemicals like galactinol may give way to an increase in the presence of certain microbial species within the phyllosphere.

Through a mixture of sterile planting of *Arabidopsis thailiana* and controlled application of defence compounds to the leaves of the plant we hope to induce a change in the phyllosphere microbiome.

Coupling this with current advances in community composition analysis via Droplet Digital PCR can allow for absolute abundances of bacteria to be gleamed from leaves which will allow for more robust community composition (3).

- The secondary metabolites which are to be investigated are;

Coronatine: A Jasmonic Acid analogue which pathogens secrete in order to stop the pathogen response in *A thailiana.*

*Chosen due to it being a chemical released by pathogens in order to circumvent the host-plant from eradicating the pathogen – which may have an effect on the microbiome*

Urate: A common anti-microbial defence compound

*A common defence compound.*

3-(Isothiocyanatomethyl)-1H-indole [ITC]: A glucosinolate compound which is an anti-herbivore agent.

*One of more common mustard herbivore defence compounds. Will be interesting to see the effects it may have on the microbiome.*

Galactinol: A sugar based defence chemical with anti-microbial properties.

*Already known to be utilized by one pathogen as a nutrient and may also be utilized by other microbes as such.*

References

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3.Morella, Norma M., Annika L. Gomez, Grant Wang, Michelle S. Leung, and Britt Koskella. "The impact of bacteriophages on phyllosphere bacterial abundance and composition." *Molecular ecology* (2018).

Kniskern, Joel M., M. Brian Traw, and Joy Bergelson. "Salicylic acid and jasmonic acid signaling defense pathways reduce natural bacterial diversity on Arabidopsis thaliana." *Molecular plant-microbe interactions* 20, no. 12 (2007): 1512-1522.

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Pathogen Species in the Phyllosphere

-  *Pseudomonas fluorescens*

Ideas

- There are examples of change in composition of the microbiome due to the presence of a secondary metabolite (see Joy’s paper), but I want to hone in on exactly what microbial interactions are being affected by the presence of this chemical.

- I need a stable hypothesis though. Something along the lines of “Does the presence of galactinol affected the pathogenic load/virality of the pathogens present in the system?”

- This is similar to what Joy and I talked about the other day when we were speaking about how there are certain micrbobes, that when are present in the community, they can take on different roles that may not align with what they were doing previously.

Switching to the root rhizopshere – it is just not reasonable to look at the rhizosphere until I can get a grip on the root system.