Illuminating the Rhizosphere of *Brachypodium distachyon* Aided by Fabricated Ecosystems

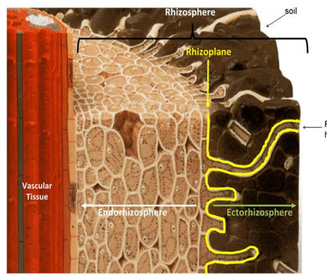
Christal Nevarez[1, 2], Nameera F. Baig[3] and Romy Chakraborty[3]
[1]Transfer to Excellence Research Experience for Undergraduates Program, [2]Skyline College, San Bruno CA
[3]Ecology Department of Lawrence Berkeley National Laboratory , University of Berkeley, Berkeley CA

Abstract

***Abstract* - The rhizosphere is a highly complex and dynamic region where plant roots interact with microbial communities in the soil. Several factors such as plant organic matter and the inherent chemical properties of the soil play a crucial role in influencing plant growth and shaping the rhizosphere. Studying the rhizosphere is crucial for illuminating carbon cycling and design strategies for promoting plant growth as well as sustainable agricultural practices. The objective of this research project was to employ ion chromatography (IC), biomass analysis, DNA extraction and 16s sequencing to characterize soil chemistry and the microbial biomass in the rhizosphere. We used mesofluidic devices called EcoFABs (fabricated ecosystems) to grow model grass *Brachypodium distachyon* in a highly reproducible laboratory setting over the course of two weeks in three different types of solid substrates namely, a rich agricultural soil, a marginal soil and sterile quartz sand. We measured the plant biomass and the biochemical properties of the rhizosphere at the end of two weeks. Our results reveal that the measured plant biomass varies based on the type of soil substrate in which the plant grown is grown with relatively higher biomasses observed when the plant is grown in the rich agricultural soil. The findings of this study underscore the complex synergy between soil chemistry, plants and the soil microbiome in shaping the rhizosphere and affecting plant growth.**

Background

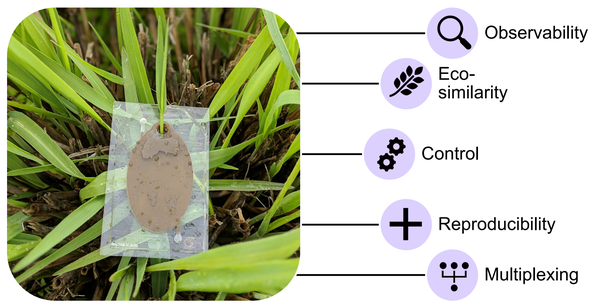
Rhizosphere



(Figure 1) Displays the rhizosphere

- Dependent on the complex interactions between plant exudates and microorganisms
- Several factors influence plant growth and shaping the rhizosphere [1]
- The region consists of a longitudinal and radial gradience in physical, chemical, and biological properties [2]

Fabricated Ecosystems

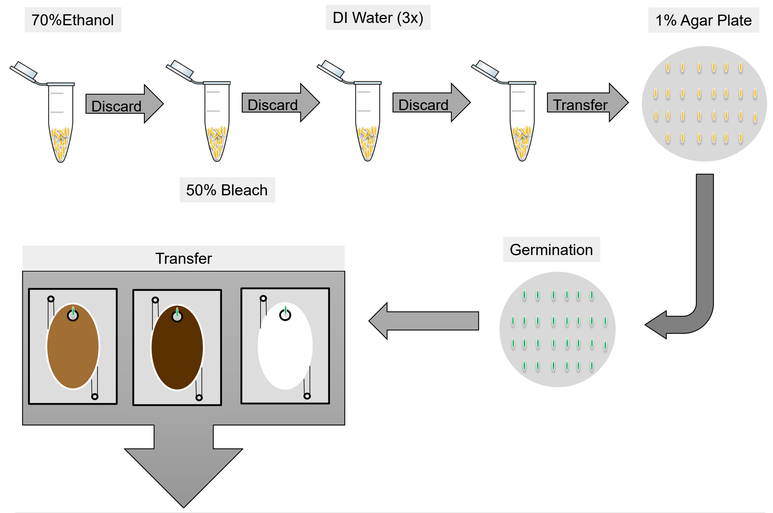


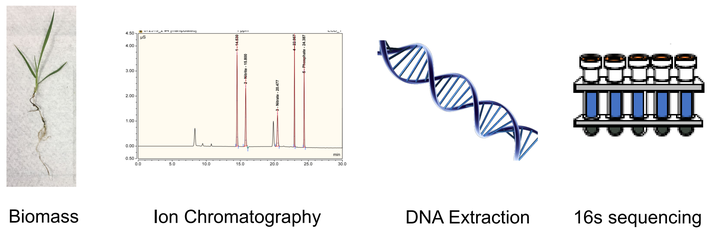
(Figure 2) Demonstrates the benefits of EcoFABs

References

1.Brink, S. (2019). Unlocking the Secrets of the Rhizosphere. [online] Trends in Plant Science. Available at:https://www.cell.com/trends/plantscience/fulltext/S1360-1385(16)00036-4#%20 [Accessed 15 Jul. 2019]
2. McNear Jr., D. H. (2013) The Rhizosphere - Roots, Soil and Everything In Between. *Nature Education Knowledge [Accessed 15 Jul.2019]*
3. Collins, A. A. (n.d.). Retrieved from https://projects.ncsu.edu/cals/course/pp728/Agrobacterium/Alyssa_Collins_profile.htm [Accessed 7 Aug. 2019]

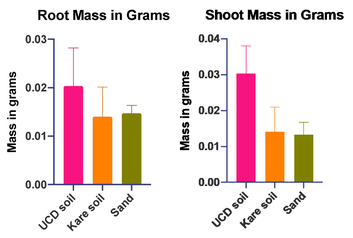
Methods



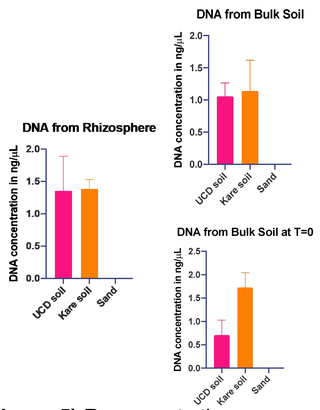


(Figure 3) Demonstrates the workflow of the experiment

Results

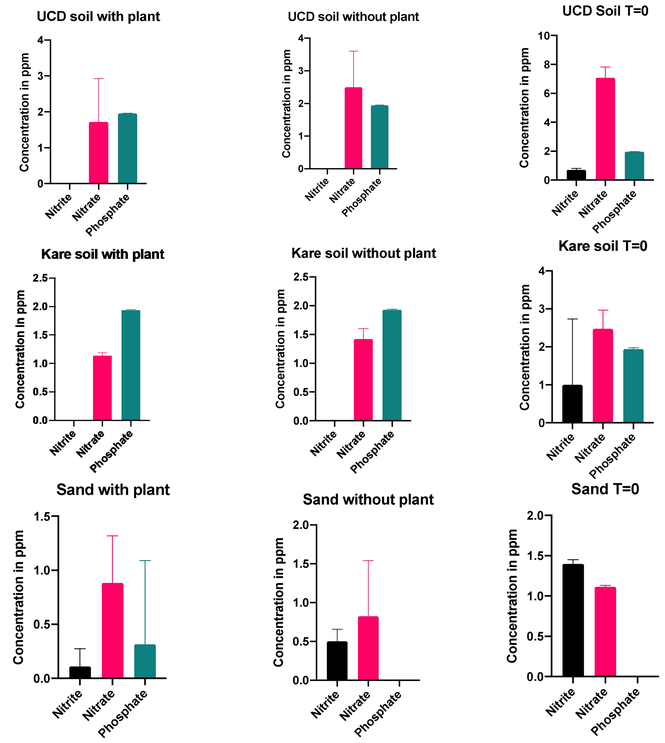


(Figure 4) Represents the average biomass comparing the root & shoot mass in the different substrates.

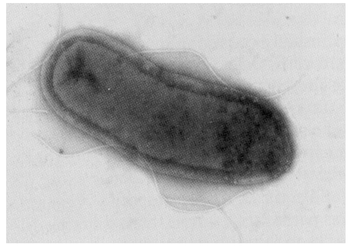


(Figure 5) Represents the average DNA extracted per gram of soil across the different substrates.

Results Continued



(Figure 6) Exhibits the average anion concentration per gram of soil within the various substrates.



(Figure 7) Rhizosphere bacteria : *Agrobacterium fabrum* [3]

Conclusion

- In characterizing the rhizosphere it is important to account for and identify the rhizobacteria that reside.
- The soil chemistry directly influences the rhizosphere as seen in the amount of nitrate to biomass ratio.
- With further research, the rhizosphere can be engineered to increase in crop yield leading to an improved food security.

Acknowledgments

I would like to express gratitude towards TTE REU and National Science Foundation for providing me with this amazing experience. It gave me the opportunity to understand the inner workings of a research facility and give me clarity towards possible career paths. Thank you to Nameera Baig (mentor), Lauren Jabusch (From LBL Potter location), Romy Chakraborty (PI) and her team for guiding and advising through my project. The Chakraborty lab is a powerhouse full of women determined to better our environment and I am grateful to work alongside them.

This work was funded by National Science Foundation Award #1757690