

Introduction

• A long-term goal of NASA's Artemis program is to establish the Artemis Base Camp for astronauts to live and work in on the Moon [1].



Figure 1: Artist rendition of a Moon base. Credit: ESA - P. Carril.

• In situ resource utilization is being researched for sustainable crop production [3].

• Authentic lunar regolith samples from Apollo missions have been shown to induce stress on *Arabidopsis thaliana* during growth [4].

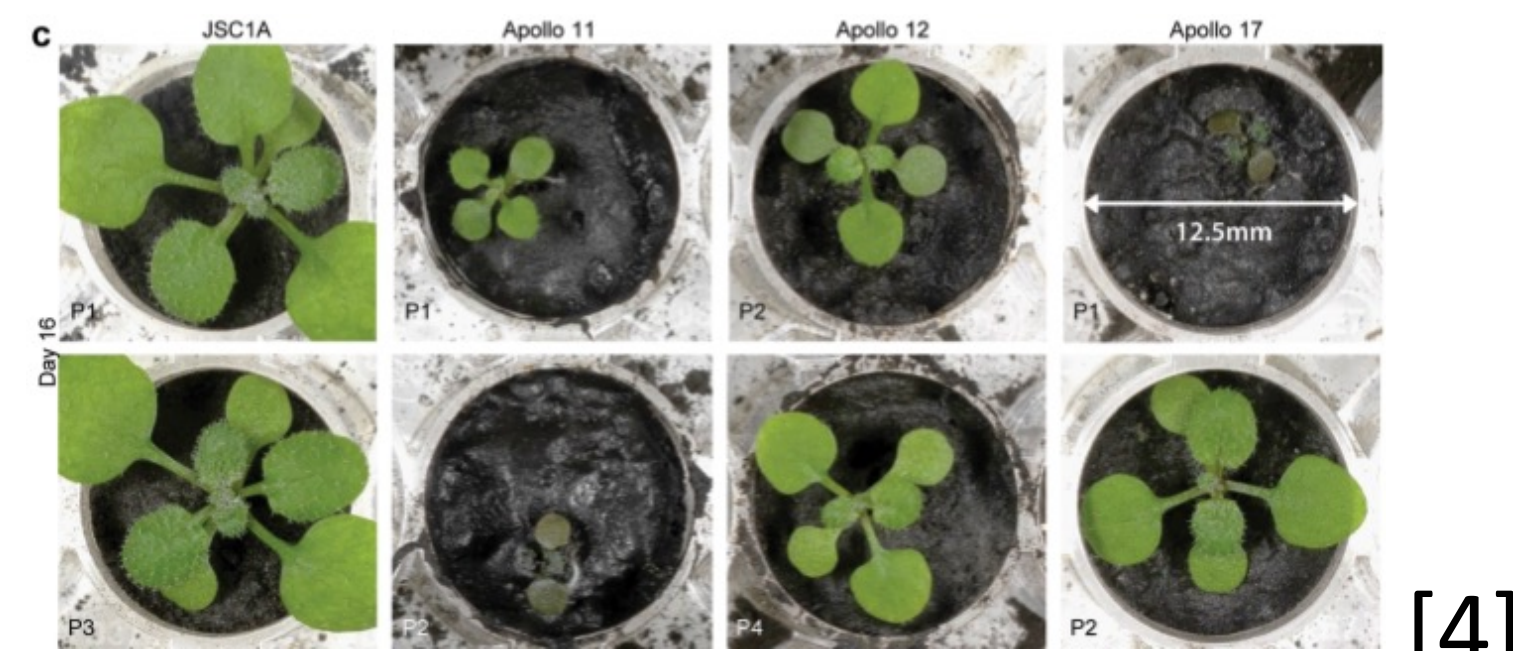


Figure 2: Growth differences shown in authentic lunar regolith and JSC-1A lunar regolith simulant.

• Biomass waste, such as manure used as a source of nitrogen and microbial communities, could make lunar regolith a more hospitable substrate for plants [5].

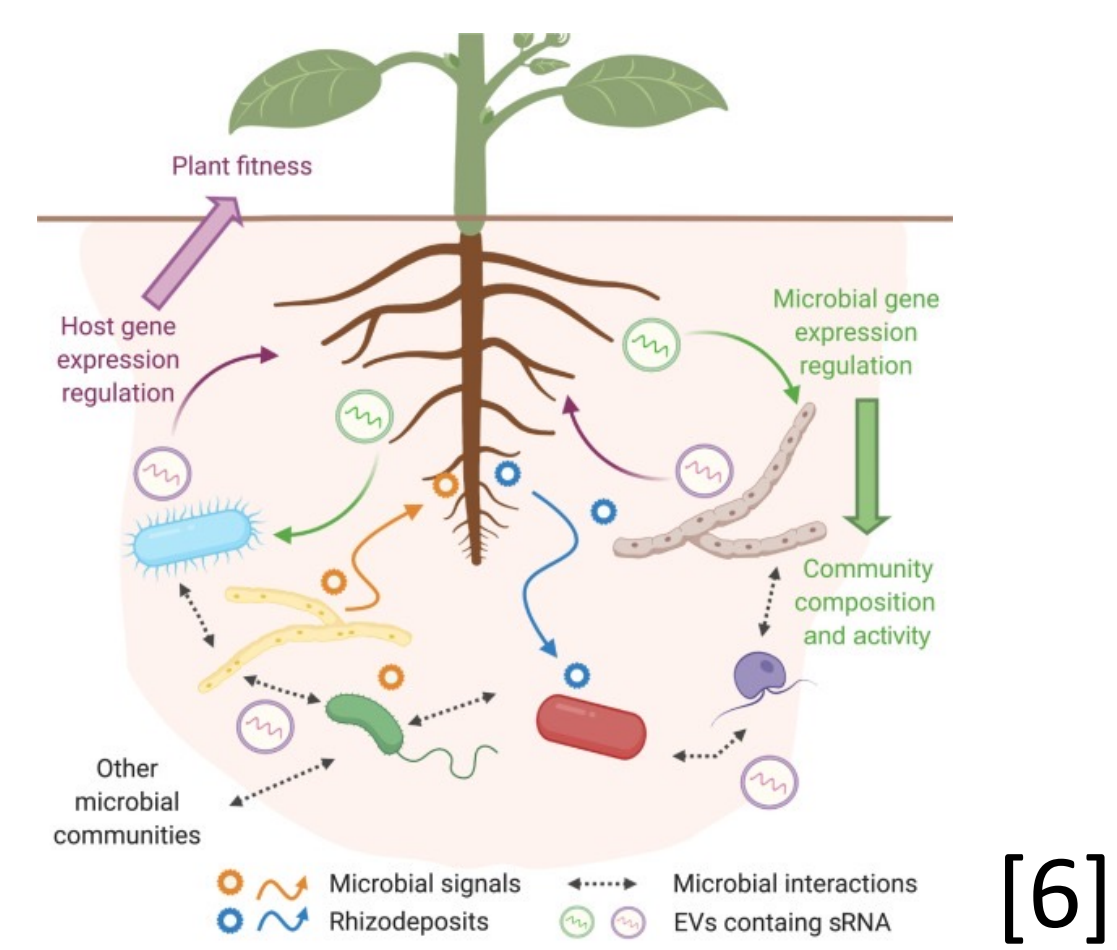
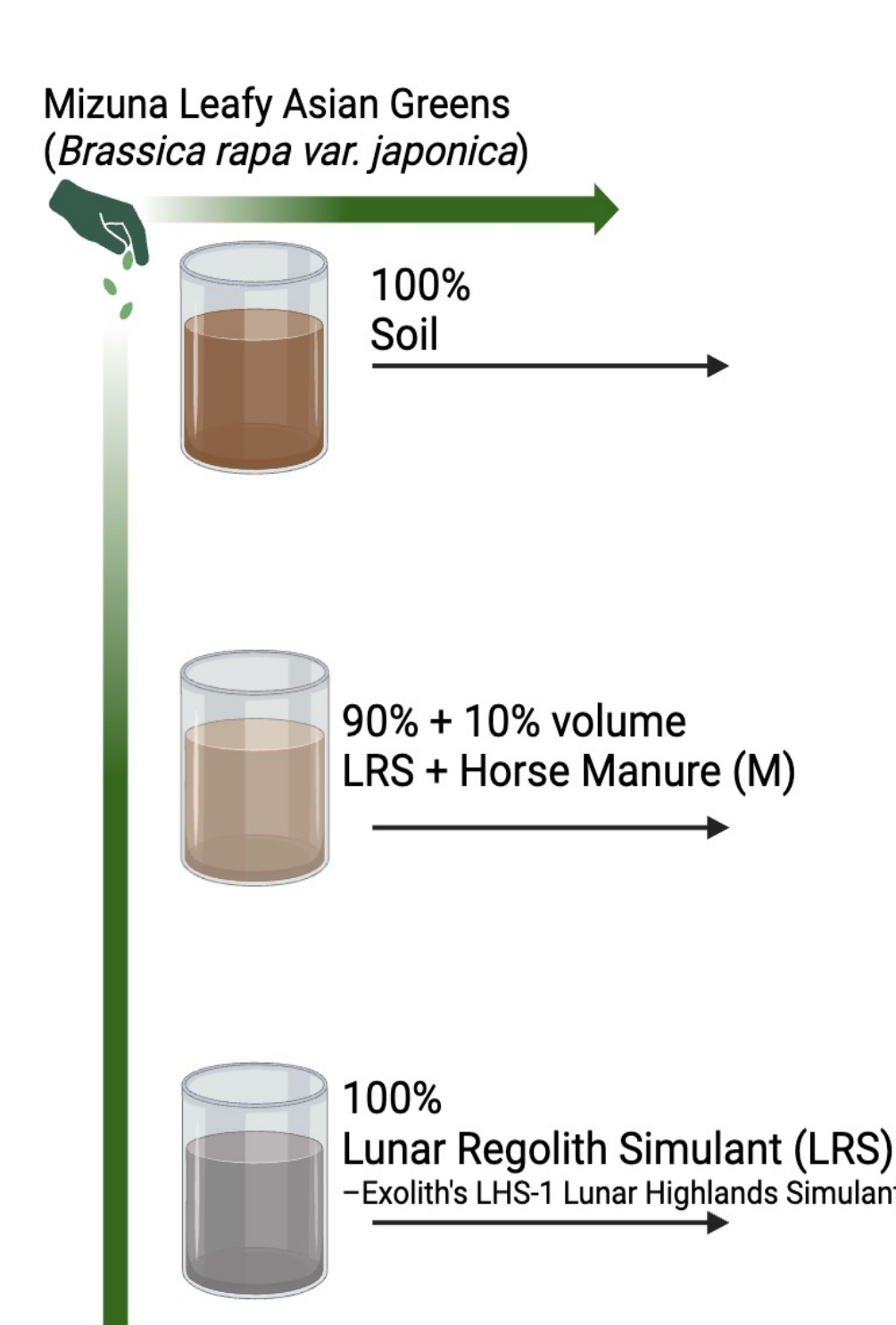


Figure 3: Interactions within rhizosphere.

• We hypothesize that the addition of horse manure to the lunar regolith simulant will lead to greater plant growth in successive growth cycles due to a greater concentration of diverse microbial communities in the plants' rhizosphere.

Experimental Design



Week 3 (Mar. 4, 2024) of first growth cycle:

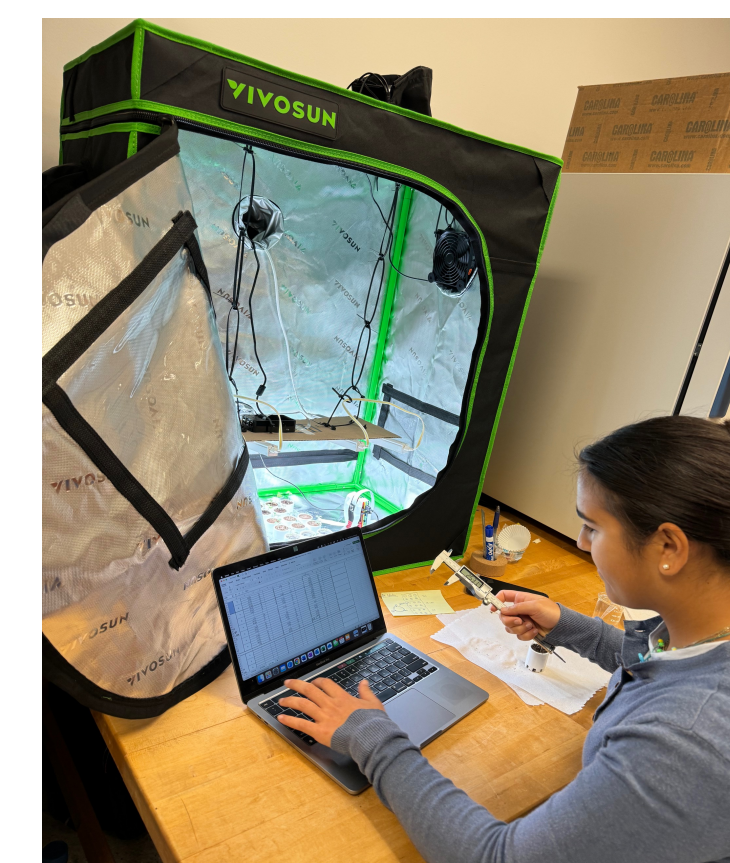


VIVOSUN Grow Tent set-up at start of experiment, Week 1.

Figure 4: First growth cycle experimental set-up.

Preliminary Results

- First growth cycle (Feb. 17 - Mar. 13, 2024)
- The LRS + M treatment had an overall increasing trend with a greater average plant height over the 4 weeks than the LRS treatment.



Researcher collecting plant height data.

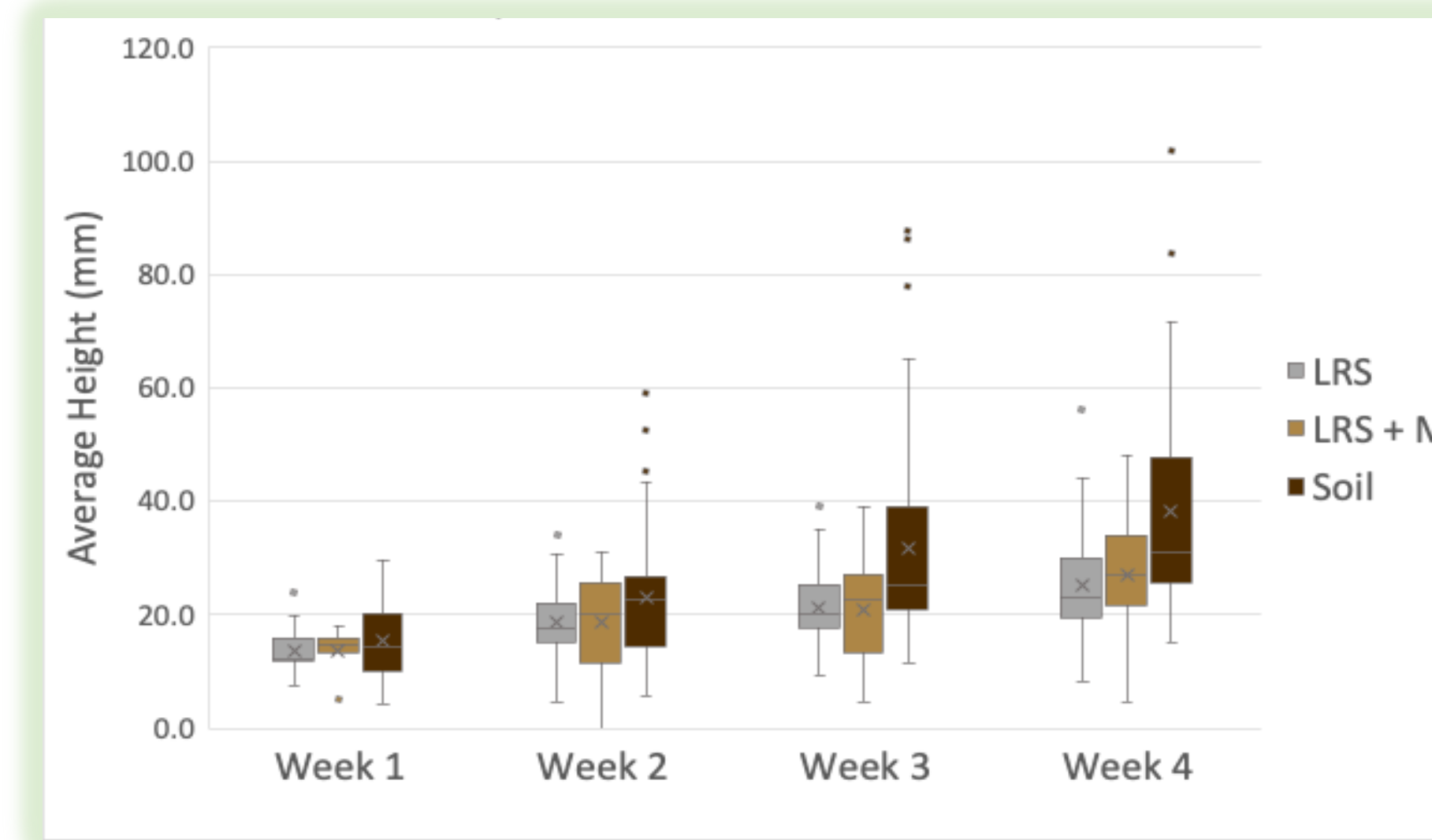
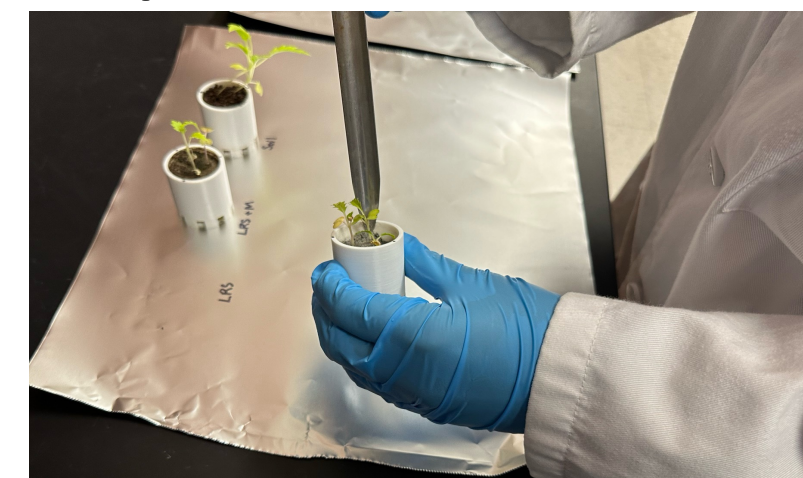


Figure 5: First growth cycle weekly average heights of Mizuna in simulated lunar conditions.

- Rhizosphere collection and root structure analysis:



Researcher harvesting substrate.

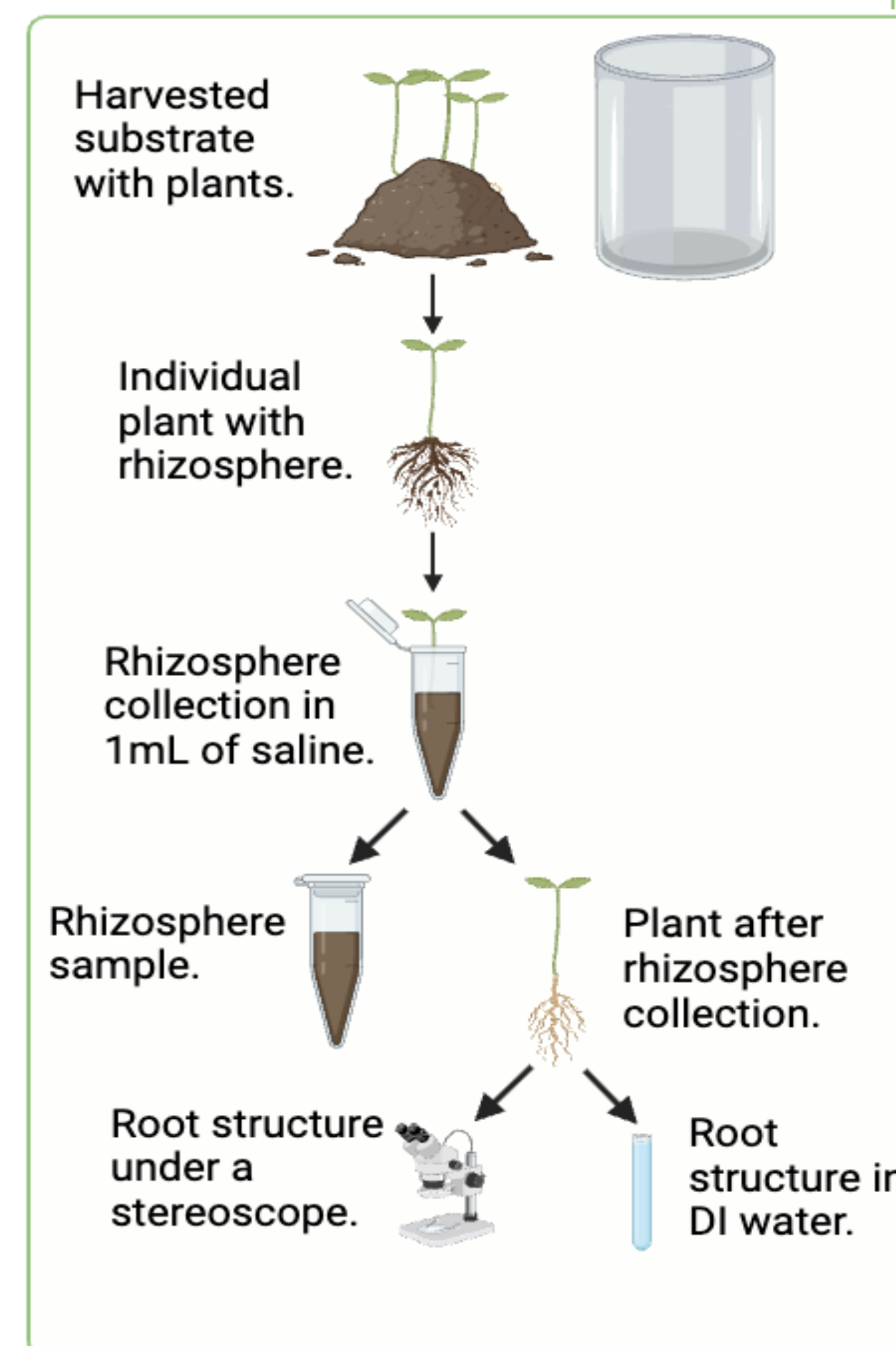


Figure 6: Rhizosphere collection procedure for plants in each substrate.

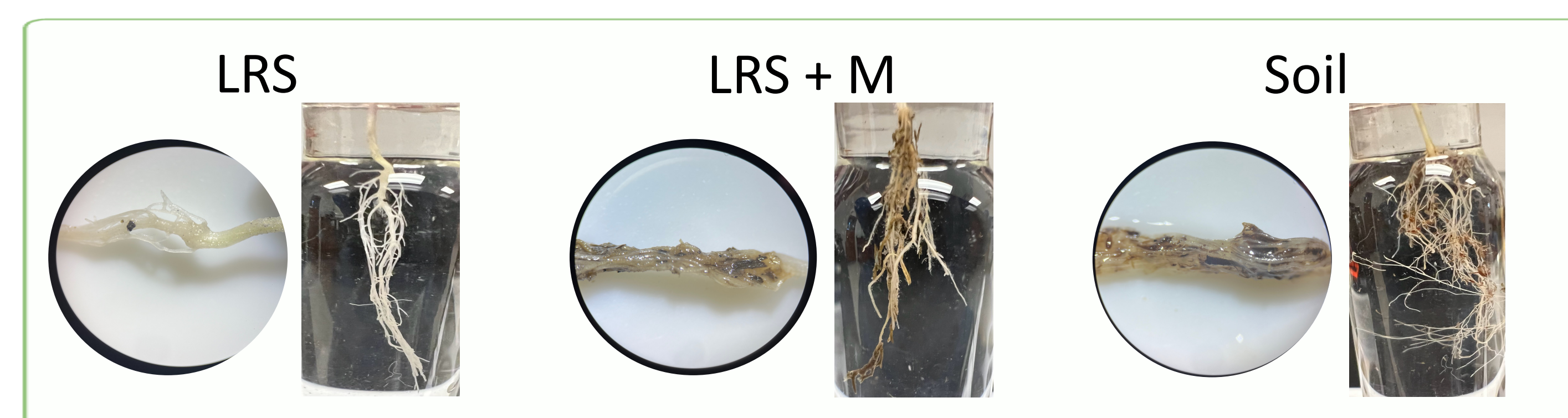
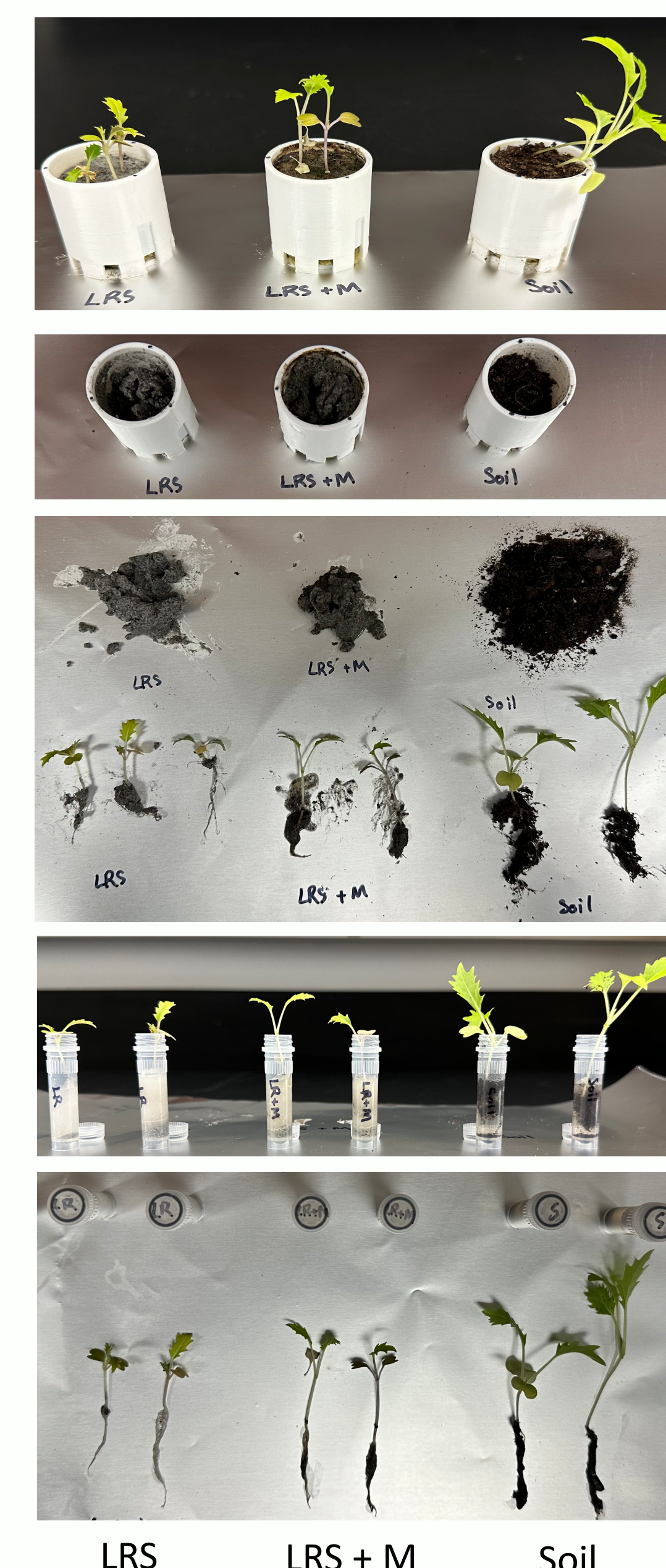


Figure 7: Root structure differences shown under a stereoscope (20X) and in DI water.

Preliminary Results

- Microbial analysis:

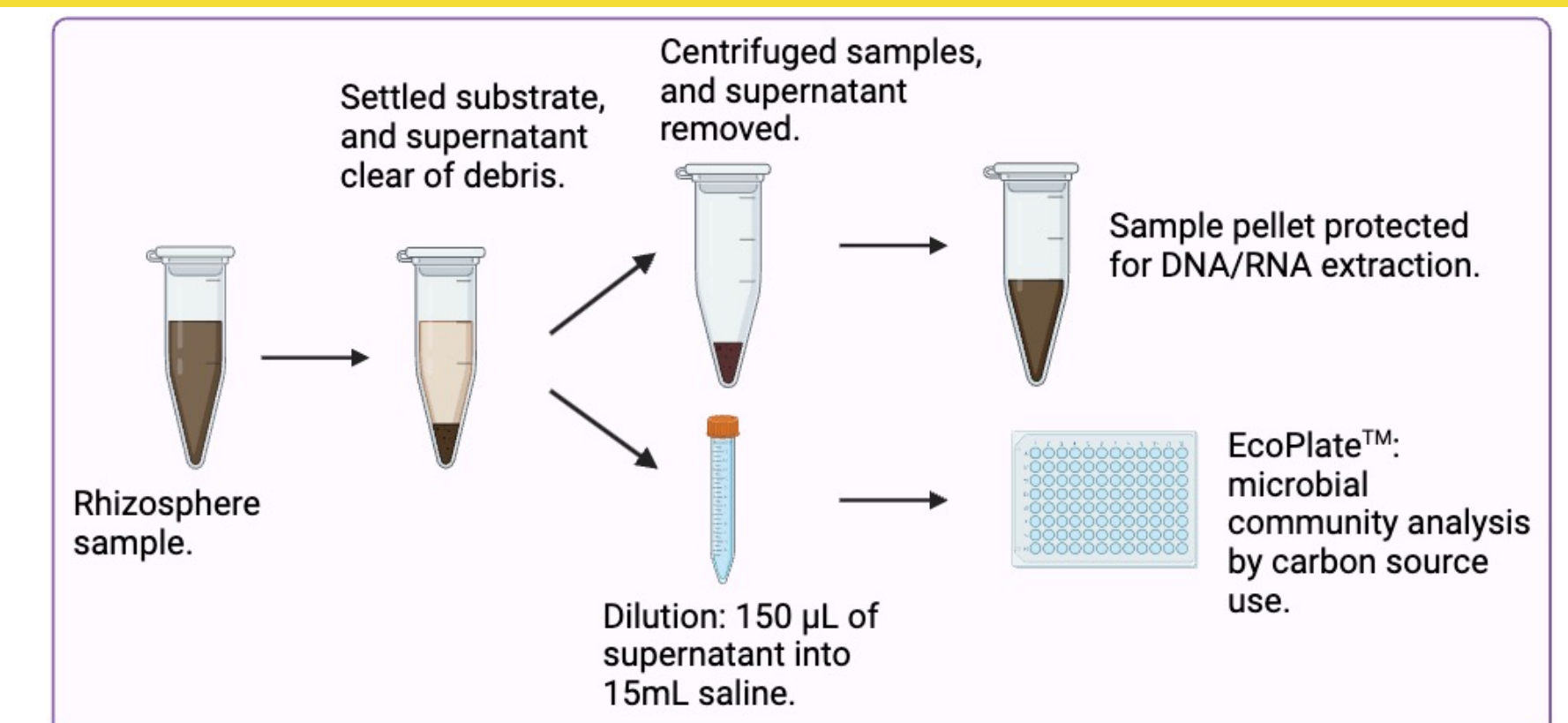


Figure 8: Microbial analysis procedure for each rhizosphere sample.

- The EcoPlate™ data shows the different and amount of carbon source use of the rhizosphere samples' microbial communities.
- The LRS + M rhizosphere sample shows the greatest use of the amino acid, amine, and polymer groups' carbon sources indicating a larger and more diverse microbial community than in the LRS rhizosphere sample.

Amino Acids and Amines

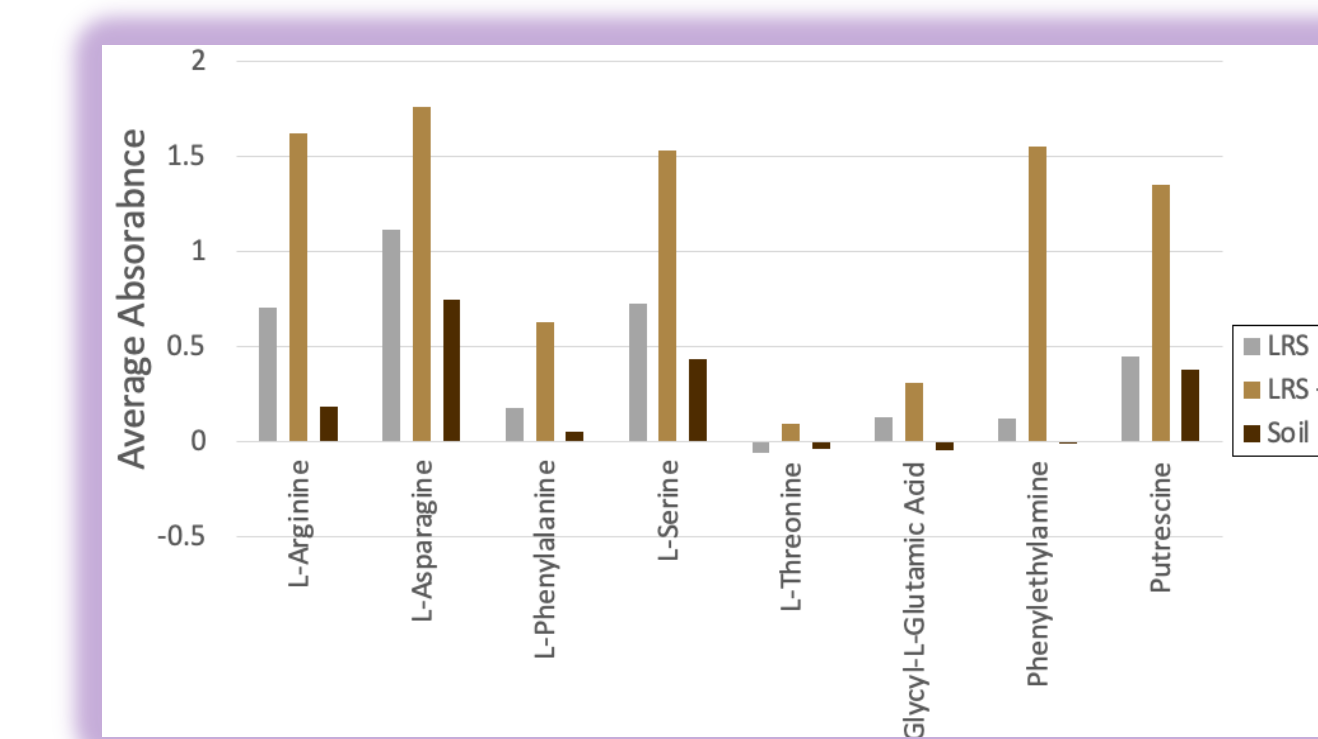


Figure 9: EcoPlate™ data for the amino acid and amine groups.

Polymers

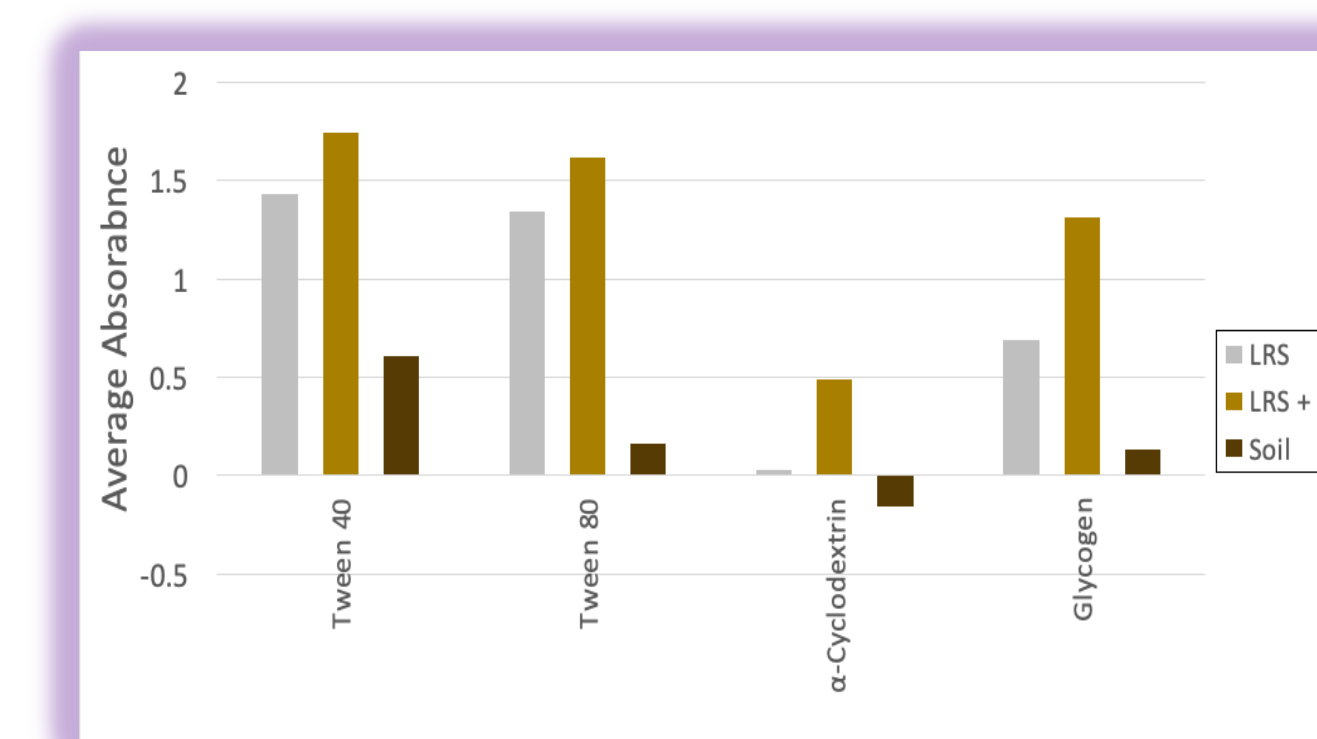


Figure 10: EcoPlate™ data for the polymer group.

Current Work

- Second growth cycle, the first successive growth cycle, is in progress. The root systems from the previous growth cycle are left in the substrate.
- DNA/RNA extraction and DNA libraries to further characterize the microbial communities found in the rhizosphere samples.

Next Steps

- LRS + M mixture volume by volume ratio (v:v) experiment for optimal Mizuna plant growth.

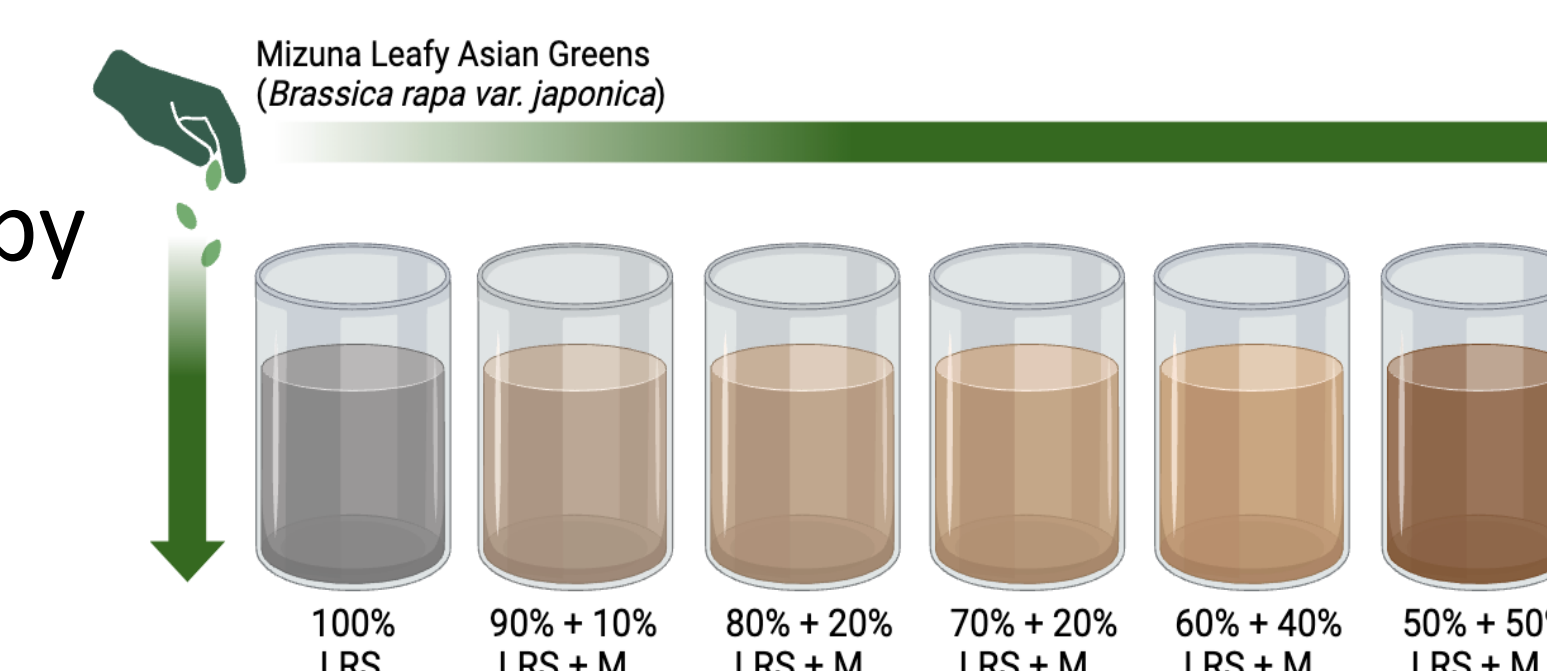


Figure 11: LRS + M mixture (v:v) experimental set-up.

References

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