P.E.A.N.U.T.S.: Promoting Extraterrestrial Agriculture through Novel Utilization Techniques for Sustainability

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Background

- **Space crop production** is mission-critical for the safety of astronauts and mission-success.
- **Regolith-based agriculture** could be a cost-effective method to improve food security and waste recycling.
- The dusty regolith on the Moon or Mars presents **compaction challenges to roots** via limited water holding capacity (WHC) and aeration.
- On Earth **substrate-spacers** are utilized to improve root-zone moisture and oxygenation.
- **Peanut (*Arachis hypogaea*)** produces protein rich edible biomass as well as **lignocellulose** (plant fiber) **rich inedible biomass**.

We hypothesize that the redistribution of the inedible biomass generated by peanut plants will promote regolith-based agriculture through substrate-spacing capabilities.

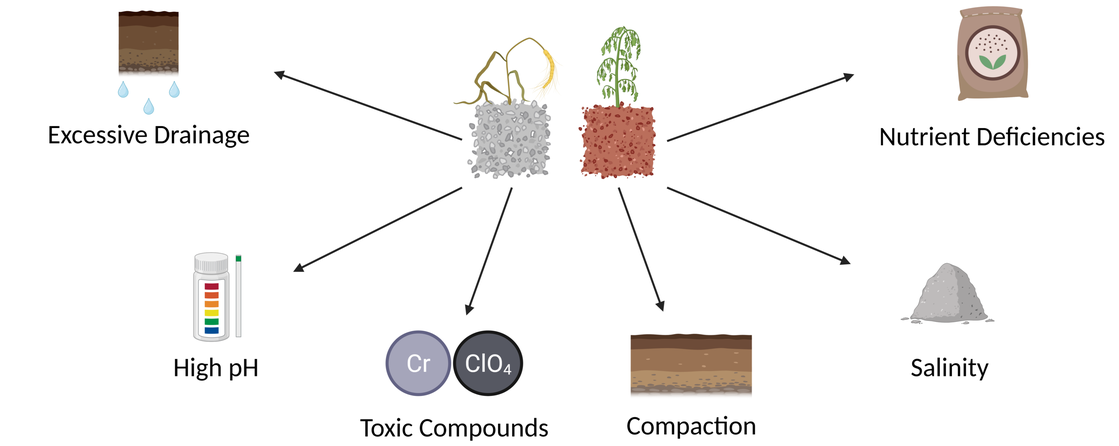

Figure 1: Generalized challenges imposed on regolith-based agriculture.

Methods

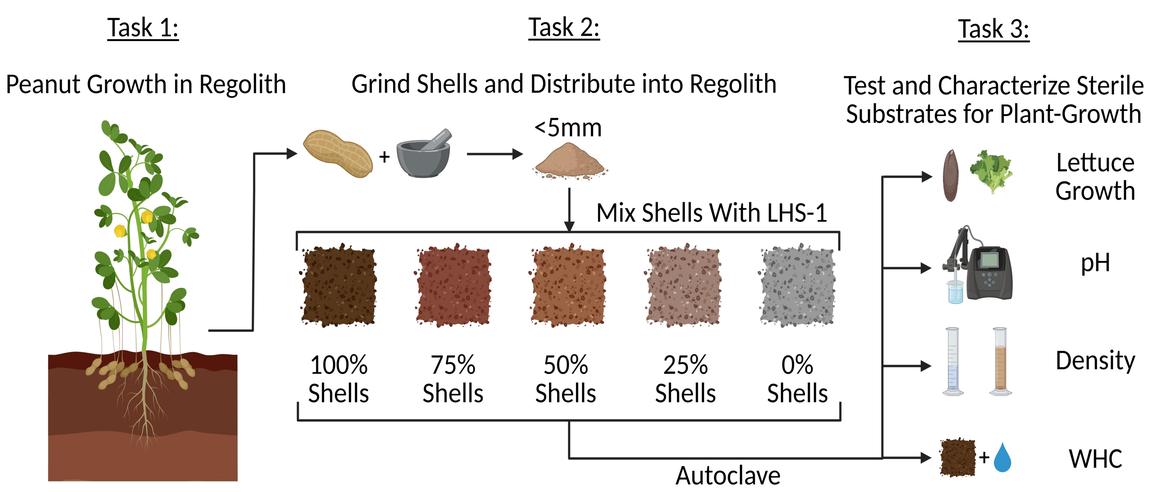

Figure 2: Experimental design of testing peanut growth in regolith simulant, using peanut shells as a substrate-spacing amendment, and characterizing the plant-growth capabilities of peanut-amended regolith. Peanuts grown for 110 days and lettuce *(Lactuca sativa)* grown for 90 days. (LHS-1=Lunar Highland Simulant-1)

Results

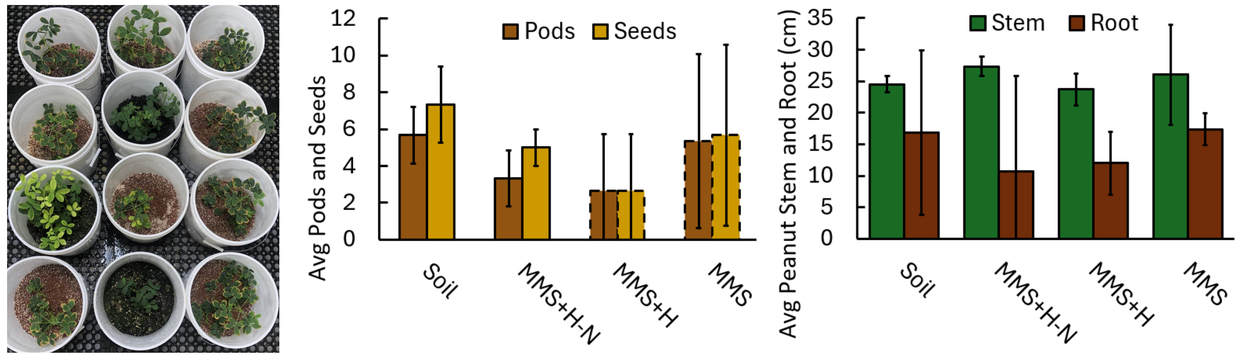

Figure 3: Average stem and root lengths (left) and average pod and seed growth (right) of peanuts (n=3). Dashed lines indicative of a plant not producing pods (zero in data). MMS=Martian Mojave Simulant. (Stem P-Value: 0.737) (Root P-Value: 0.813) (Pods P-Value: 0.568) (Seeds P-Value: 0.386)

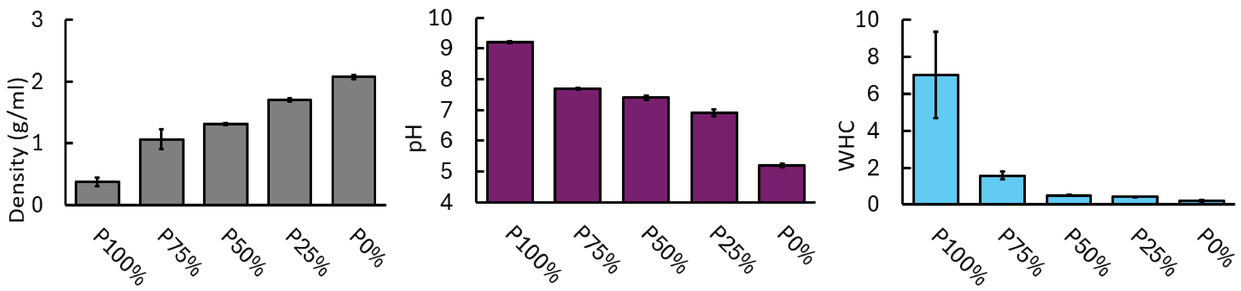

Figure 4: The density (left), pH (middle), and water holding capacity (right) of each ratio of peanut amended regolith. (Density P-Value: 4.43×10^{-7}) (pH P-Value: 1.89×10^{-13}) (WHC P-Value: 0.046)

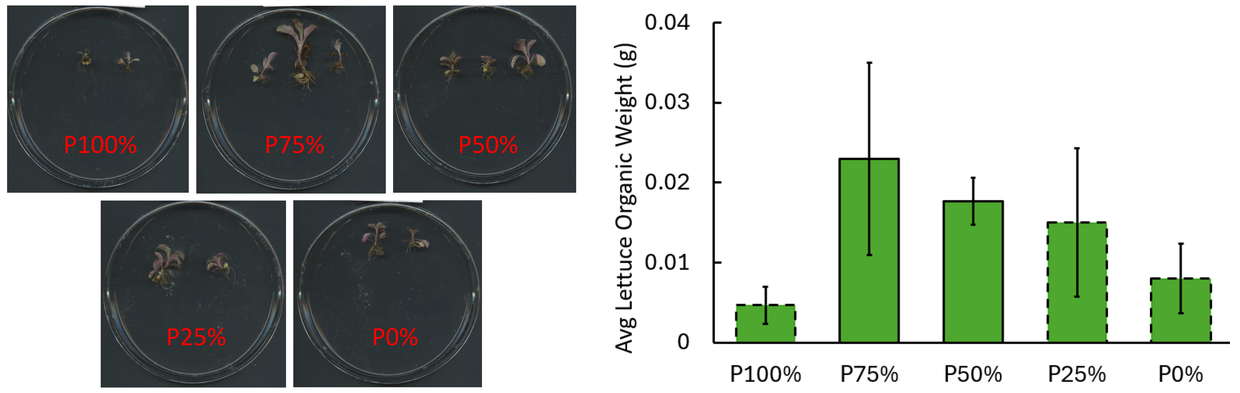

Figure 5: Images of harvest (left) and average organic weight (right) of lettuce (n=3). Dashed lines indicative of a plant not reaching harvest (zero in data). (P-Value: 0.436)

Discussion

- Peanuts can viably grow in Martian Mojave Simulant with little amendment insisting they are a **viable candidate for regolith-based agriculture.**
- Peanut shells mitigate the densely compactible, alkaline, high drainage LHS-1 to create a **more favorable substrate for plant growth.**
- Increases in plant size and amount **justifies peanut shell-amended regolith** as a plant-growth substrate.

References & Acknowledgements

Figures 1 and 2 Generated with Biorender

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