Uncovering the effects of off-planet microgravity on microgreens through the utilization of enriched Martian regolith.

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Why attempt to grow microgreens in Martian Regolith?

- Production of food
- CO_2/O_2 conversion
- Waste Processing
- Water purification system
- Saving valuable cargo space with in-situ resource utilization
- Less dependence between Earth and Mars. (Distance)

Challenges of Growing Plants in Martian Soil:

- Poisonous perchlorates
- Lack of nutrients
- Large particle sizes of soil
- No microbiome environment
- Extreme cold temperatures

Why attempt to grow microgreens in Martian Regolith… in microgravity?

- Launching plants into space is not a new topic! NASA has launched plants into space since the 1960's. (Ex: Bion Program participant)
- Growing plants in microgravity is not a new topic either! The International Space Station is host to the Vegetable Production System (Veggie) and the Advanced Plant Habitat (APH). Astronauts have grown lettuce, cabbage, mustard, and kale.
- Despite the numerous experiments conducted with Martian Regolith soil in 1/3rd G (Martian Gravity), further research must be done with microgravity conditions to fully discover the growing potential of Martian Regolith in space.

The Experiment:

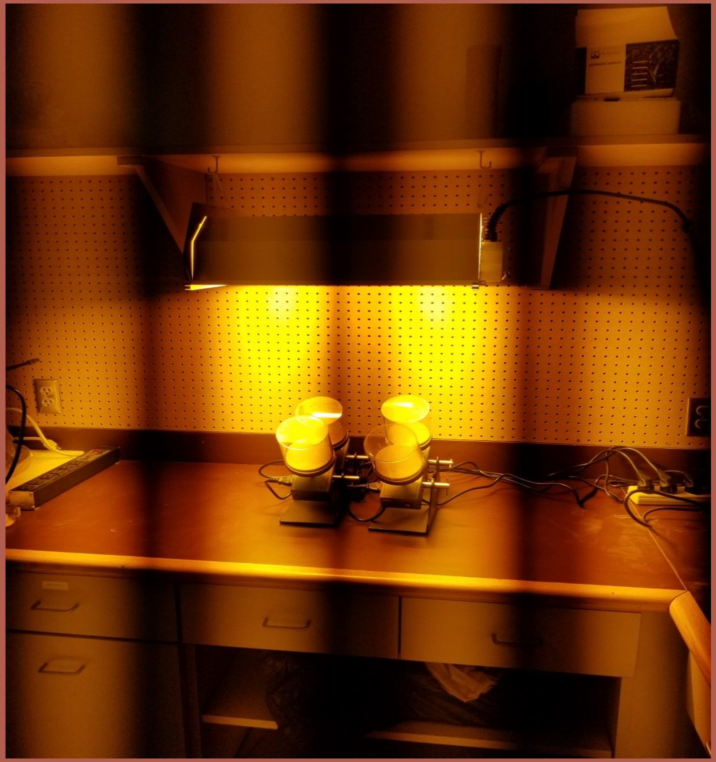
4 Groups:

- Group 1 (Control Group): 100% MGS-1, 0% Topsoil
- Group 2: 75% MGS-1, 25% Topsoil
- Group 3: 50% MGS-1, 50% Topsoil
- Group 4: 25% MGS-1, 75% Topsoil

* Each group contains grounded vermiculite.

- The MGS-1 (Martian Global Simulant-1) soil is a product of Exolith labs by the University of Central Florida. It uses mineralogy reports from previous Mars rover missions to create a similar product.
- Topsoil is used to enhance the soil with added nutrients.
- Clinostats are used to simulate microgravity. The soil and seeds are placed inside the base of the instrument. It is rotated to a 180-degree angle to best simulate 0 G.
- Radishes were finalized as the chosen microgreen. The radish growth cycle is 24 days.
- Radishes receive 8 hours of lamplight, and water in the morning. Room temperatures remained at around 70 degrees Fahrenheit with 20% relative humidity.

The tools:



Space Life Sciences Laboratory

Vermiculite

Clinostats

My Initial Hypothesis:

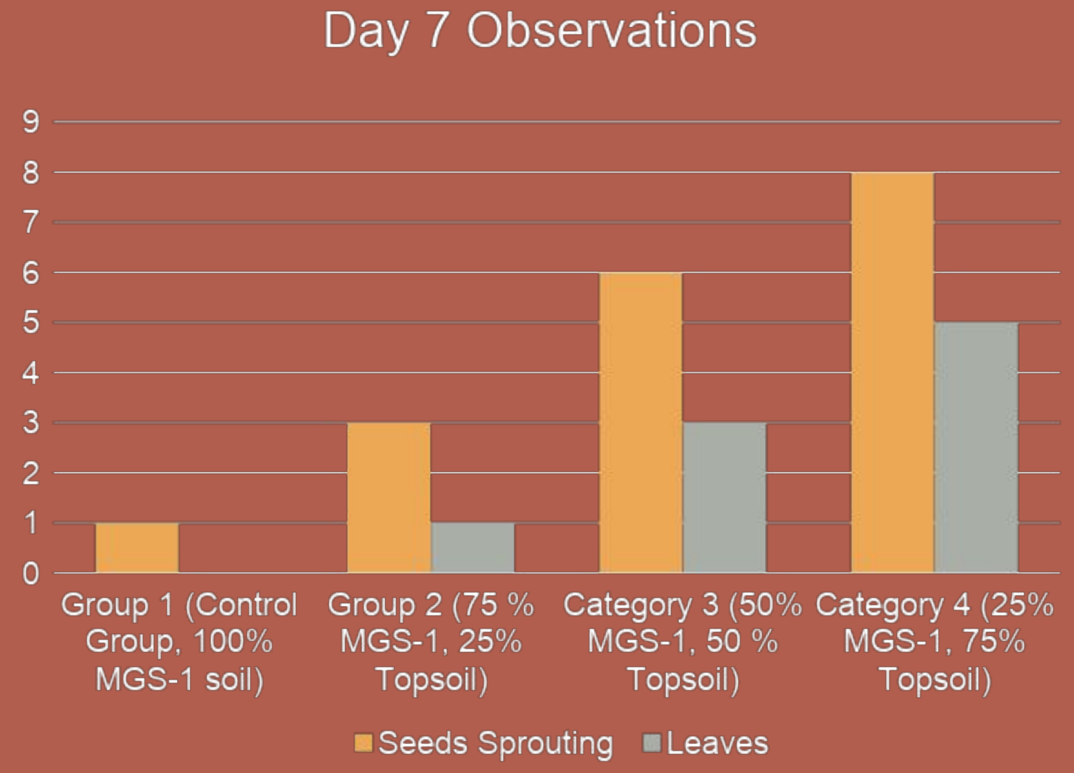
- As the topsoil % increases in the Martian Regolith enhanced mixtures, the number of mature microgreen radishes will increase. The number of leaves, stem length, and plant longevity should increase too.
- 0 gravity will impact directional growth horizontally.
- 0% of the radishes will grow in the control group.

Week 1:

- Germination occurred in all four groups (including the control group) on the 4th day! They were all growing horizontally.

But on the same day…

- Later that evening, I went to the lab and found the equipment off, but all the switches were on. The radishes sensed gravity and began growing upwards. The machines were off due to overheating. After moving equipment around, the experiment returned to normal on the 5th day. Stems grew horizontal again.

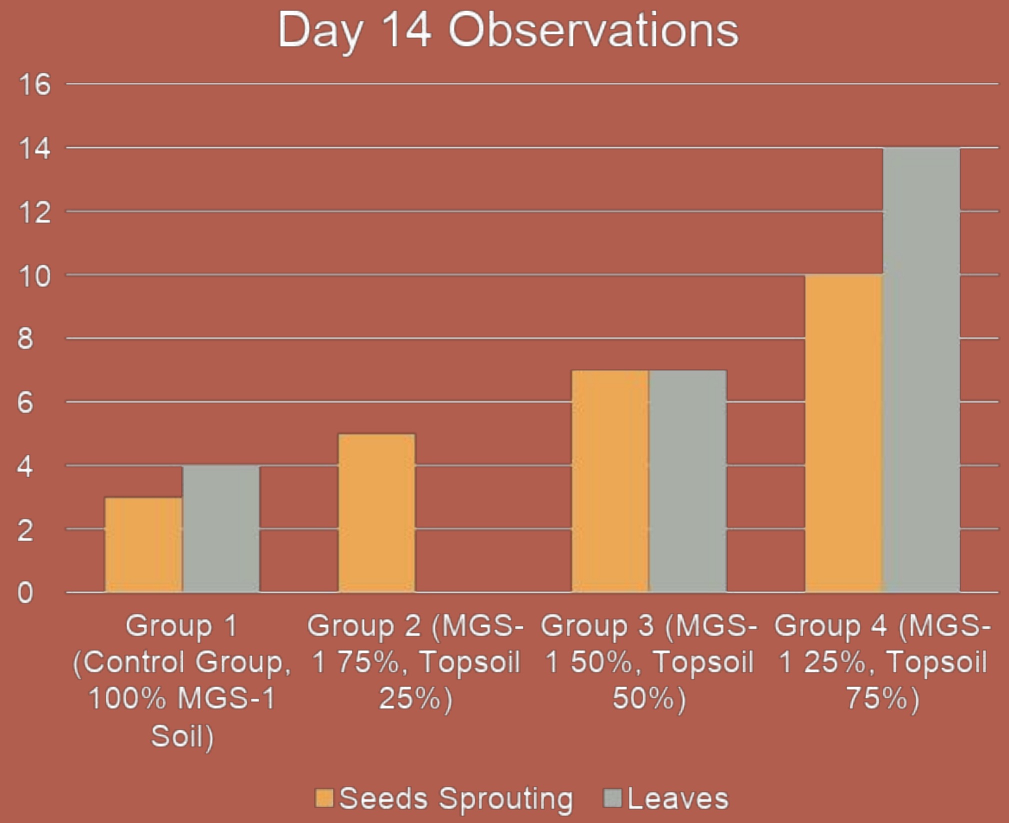


Day 4 incident effects on Groups 1 & 2

- Group 1 (control group) clinostat starts to experience mechanical issues. The machine kept rotating slower each day afterward until it completely stopped in week 2.
- Group 2 soil mixture began to clump off the base of the clinostat and onto the clear container as a result of no continuous rotation.

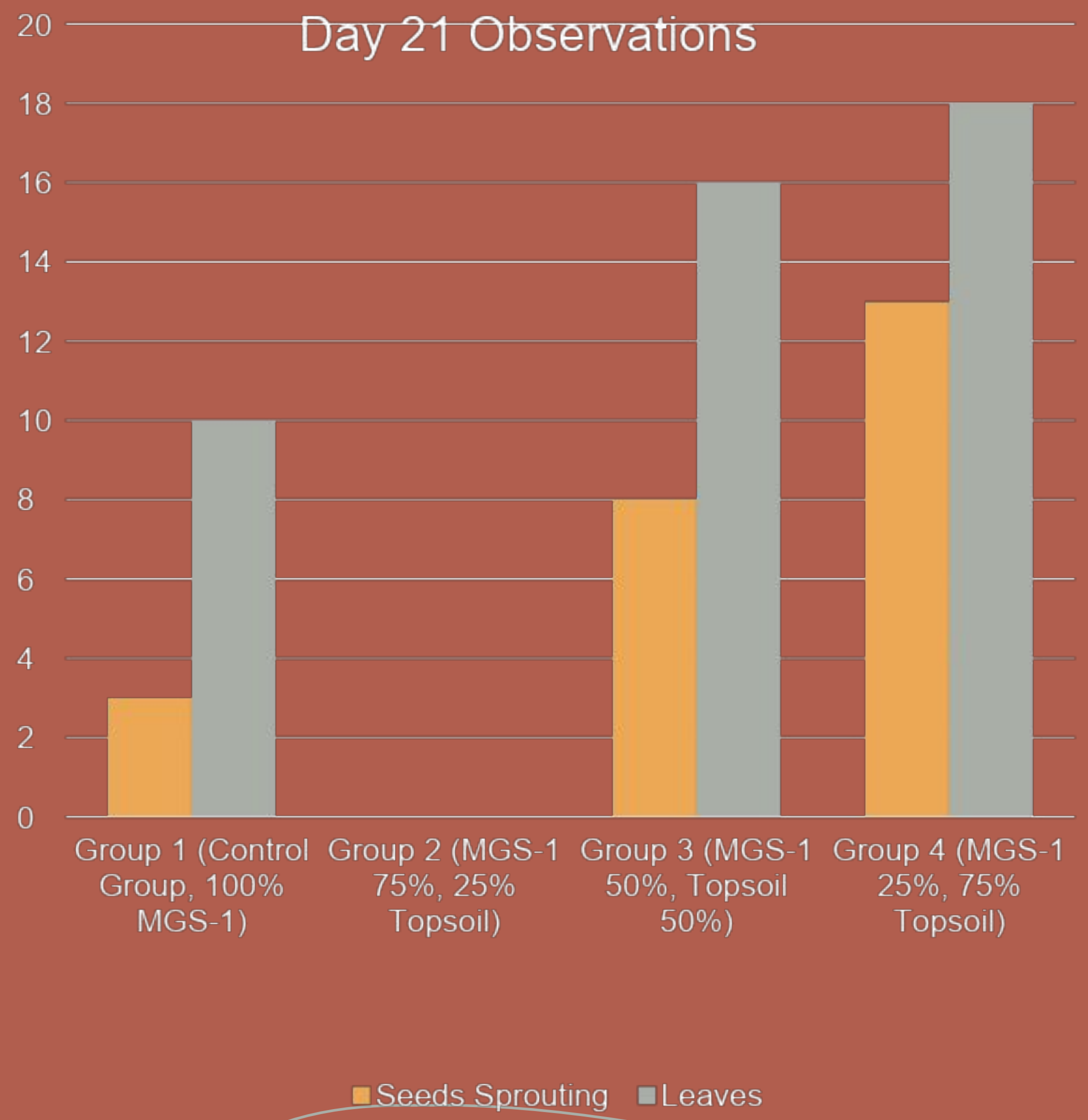
Week 2:

- Group 1 (control group) continued to have a steady growth. Despite the clinostat malfunction, the radishes continued to receive regular light and water. Their direction of growth is upward now. Leaves begin to emerge and are green.
- Group 2 seeds continued to grow, but rather mostly from the sides of the flask rather than the base.
- Group 3 & Group 4 continued with regular conditions. The result is an abundance of stems growing horizontally from both clinostats. Leaves begin to emerge, and a small red color was visible in Group 4.



Week 3 + 3 more days

- Group 1 (control group) has a couple of long stems growing. Multiple leaves are shown and are turning yellow. One stem is red. All are growing upwards.
- Group 2 stems are beginning to die as the water pulls the vulnerable seeds off the sides of the beaker.
- Groups 3 & 4 have multiple horizontal stems, with green/yellow leaves. The stems are long and have reached the top of the clinostat.
- This experiment is still ongoing this weekend.




Group 1
Group 2
Group 3

Conclusions

- Microgravity has a major role in the direction of growth in radishes. The increasing % of MGS-1 in a soil mixture did hinder growth development compared to higher topsoil mixtures, but they still grew to a decent size in a control group.
- Groups 3 & 4 were the most successful groups.
- Group 1 exceeded expectations with a successful batch, despite the clinostat malfunction. Another test run with the same conditions in microgravity would benefit the experiment.
- Group 2 needs to be redone for better results.
- Future projects involving clinostats would benefit from having increased awareness of having a stable base. A clinostat with a removable top would allow for more even watering and seed distribution. One of the biggest challenges was placing the soil solutions in the clinostats without soil spilling out. Awareness of the dangers of overheating is important too.

Discussion of Fellowship

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Thank you!