Crop Growth Viability on Mars' Regolith Simulant MGS-1

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Introduction

There are several ambitious plans to send humans to Mars within the next couple of decades. As we continue space travels, factors such as food growth must be explored. One of the biggest challenges faced is the lack of resources available and the inability to take excessive supplies for longer trips.

Fig. 1: MGS-1 Mars Global Simulant

The properties of Mars regolith (Fig. 1) can differ significantly from those of Earth's soil. It is deficient in nutrients typically sourced from organic matter, such as organic carbon (C), nitrogen (N), phosphorus (P), and sulfur (S) [1].

These elements are vital for plant health and development, playing key roles in cellular function and energy transfer. For successful plant cultivation on Mars, these deficiencies must be addressed. This could involve amending the regolith with organic matter or other nutrient sources to create a more hospitable environment for plant growth. The objective of this experiment is to research plant growth using MGS-1, a Martian regolith simulant [2].

Fig. 2: Organic Compost

The independent variable was the amendment of MGS-1 with organic compost with varying ratios. It is hypothesized that adding compost to the simulant could improve its properties for plant growth. The control variables were

- LED lights 12 hour on/off cycle
- Temperature
- Seeds planted (type/amount)

Acknowledgments:
Photos taken by: Erin Sylvester
Experimental influence; Plant the Moon Challenge 2024
Dedicated Growth Space: Courtesy of Tracey Lesser

Citations:

[1] Fackrell, L. E., Schroeder, P. A., Thompson, A., Stockstill-Cahill, K., & Hibbitts, C. A. (2021). Development of martian regolith and bedrock simulants: Potential and limitations of martian regolith as an in-situ resource. *Icarus*, *354*, 114055. https://doi.org/10.1016/j.icarus.2020.114055

[2] NASA. (2024, March 14). *Station Science 101: Plant Research - NASA*. https://www.nasa.gov/missions/station/ways-the-international-space-station-helps-us-study-plant-growth-in-space/

Plant The Moon Challenge. (Spring, 2024). *PTMC Educator Quick Guide*

Soil on mars | let's talk science. Soil on Mars. (2021) https://letstalkscience.ca/educational-resources/backgrounders/soil-on-mars

Methods

Two 375mL plant pots were set up for a 50:50 (Fig. 4) ratio of MGS-1 and compost. 188 mL of MGS-1 and 188 mL of organic compost were weighed for a total of 375mL and placed in their respective pots. Two 1000mL plant pots were set up for 85:15 (Fig. 3) ratio of MGS-1 and compost. 850 mL of MGS-1 and 150 mL of compost were weighed for a total of 100 mL and placed in their respective pots. 1000 mL of compost was weighed out and placed in its respective pot.

Fig. 3: 85% MGS-1 and 15% Compost ratios

Fig. 4: 50% MGS-1 and 50% Compost ratios.

The first seeds used were organic spinach seeds and each plant pot received three seeds each. The seeds were germinated before planting in a wet paper towel. Each pot received 25mL of room-temperature tap water after being planted.

All pots were set up in a controlled environment with four grow lamps. The grow lamps emit full spectrum light on a 12-hour on, 12-hour off cycle.

Due to lack of germination, reseeding took place again on February 19th with cabbage seeds, each pot received 4 seeds, and again on February 26th with radish seeds. Watering was based on how moist the soil/ regolith was.

Observations

Week 1 **February 4-10, 2024**	**Experiment started on 2/5/2024**
Week 2 **February 11-17, 2024**	**Observed plants on 2.12 and 2.15. No growth is noted**
Week 3 **February 18-24, 2024**	**Observed on 2.19, no growth noted. Re-seeded with organic cabbage seeds on 2.19.2024. Observed on 2.22. Growth seen in compost control and 50/50 ratio.**
Week 4 **February 25- March 2, 2024**	**Observed on 2.26 and 2.29. More growth seen in compost control. Growth in the 50/50 ratio is no longer viable. Re-seeded with radish seeds on 2.26.2024.**
Week 5 **March 3-9, 2024**	**Observed on 3.4 and 3.9, small sprout noted in 85/15 ratio.**
Week 7 **March 17-23, 2024**	**Observed on 3.18 and 3.21. Compost control has more growth and small sprouts seen in the 50/50 ratios. No viable sprouts in the 85/15 ratios.**
Week 8 **March 24-30, 2024**	**Observed on 3.25 and 3.28. Compost control has grown some more sprouts, 50/50 ratios have small sprouts. Nothing viable in the 85/15 ratios.**

Results and Discussion

Fig. 5: Seedlings harvested from compost control.

The results of this experiment were interesting. Progress of growth was not seen through the first half of the growth period. The compost control had the most seedlings harvested. (Fig. 5).

Pot one of the 50/50 ratio grew one seedling (Fig 6), Pot two of the 50/50 ratio did not produce any growth (Fig. 7).

Fig. 6: Pot one 50/50 ratio one seedling.

Fig. 7: Pot two of the 50/50 ratio with no growth.

Fig 8: Pot one 85/15 ratio. No growth

Fig 9: Pot two 85/15 ratio. No growth.

Pot one of the 85/15 ratio did not produce any growth (Fig. 8). Pot two of the 85/15 ratio did not produce any growth (Fig.9).

The experiment was terminated on 4.8.2024 and all seedlings were harvested and weighed. As expected, the 100% compost control had the most growth. The seedlings produced by the control weighed a total of 0.743 g. the 50/50 (1) ratio weighed 0.080 g. That is a difference of 0.663 g produced between the two pots.

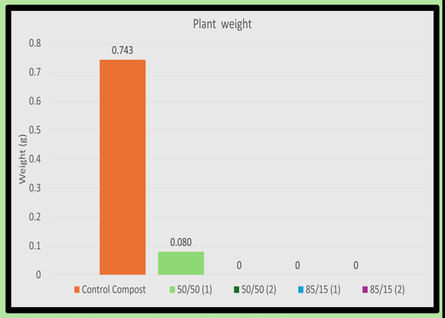

Fig. 10: Comparison of weight between seedling produced.

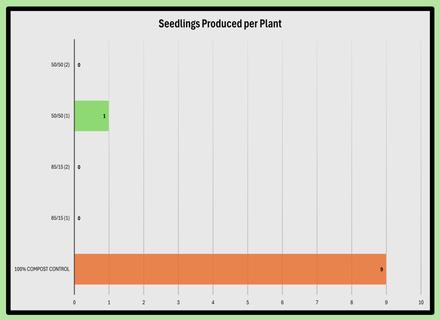

Fig. 11: Comparison of seedlings produced by each plant.

The seedlings produced by each pot were minimal. Two out of the five pots produced viable seedlings. The compost control had the most seedlings with 9 being harvested and 50/50 (1) had one seedling harvested (Fig. 11)

There could be many reasons for this outcome. The plants could likely not gather enough nutrients from the MGS-1 and compost mixture alone, causing their growth to be affected. Another likely factor was lack of water in the beginning, which delayed germination.