Aiding In the Efforts of Bioregenerative Life Support for the Future Residents of Mars and Long-Duration Space Flights
Plant Growth in Amended Martian Regolith Simulant

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Currently, the goal of plant growth research at KSC is to provide a sustainable source of healthy food on long-duration space flights so astronauts and future residents of Mars can get the nutrition they need and produce food, recycle the atmosphere, and aid in recycling water. The sustainable production of food will aid in the efforts of closed life support. Plants have a vital application for bioregenerative life support as demands for food and oxygen can be provided through photosynthesis, while the carbon dioxide from human respiration is removed. Transpiration is also used in life support processes as waste water that can be recycled through plant systems and the resultant humidity from transpiration then condensed as clean water. In order for a growing medium to provide for plant growth, it needs to provide support, oxygen, ions, and liquid to the plant. This summer research determines how amended Martian regolith simulant acts as a growing medium for plants through looking at the structural properties of each amendment.

Mars is covered with regolith which is crushed volcanic rock that is composed of a high amount of perchlorate salts. The composition of Martian soil is such that it is roughly basaltic and consists of sulfur, nitrates, and oxychlorine species. Martian regolith simulants have been generated to further analyze plant growth and aim to replicate features of the reference sample. The JSC Mars-1A regolith simulant resembles Martian regolith at the Viking I landing site. The objectives of the research this summer at Kennedy Space Center are to devise a plant growth in amended JSC Mars-1A Martian regolith simulant and perform crop studies to assess the performance of full duration crop growth in amended Martian regolith simulant. This research

will provide a deeper understanding of how the combination of soil amendments to Martian regolith has a synergistic effect on improving crop production

The plant growth experiment will be completed with three treatments each containing inorganic and organic soil amendments. The first trial of the plant growth experiment will be done with Extra Dwarf Pak Choi(EDPC).

The first treatment will measure the overall performance of EDPC growth in JSC Mars-1A autoclaved regolith simulant. Due to the sterilization step, this treatment would lack soil microbes. The second treatment will assess plant growth in JSC Mars-1A in regolith simulant that has been previously used in potato experiments and thus contains soil microbes. The third treatment/control treatment will assess plant growth in Arcillite, a calcined clay media that aids in water retention through the mechanism of capillary action, and the controlled release fertilizer. The control treatment will contain varying particle sizes of Arcillite. The plant growth parameters that will be assessed are leaf area, leaf width, leaf length, shoot height, fresh biomass, dry biomass, and chlorophyll levels.

Each of the three treatments will contain the following amendments: sphagnum peat moss, vermiculite, and perlite. Peat moss consists of dried plants and has a moderate to fine texture. Sphagnum peat moss is known for water and nutrient-holding capacity and aiding in aeration required for metabolic processes. Vermiculite is an inorganic soil amendment that consists of cation exchange properties that makes ammonium, potassium, calcium, and magnesium readily available to the plant. When vermiculite is supplemented with sphagnum peat moss, it can aid in retaining air, nutrients, and moisture. Perlite is a volcanic mineral that is known for a high permeability and low water retention properties.

In regard to the soil amendments, the sphagnum peat moss amendment to JSC Mars-1A Regolith Simulant pre-used simulant will exhibit the most favorable growth conditions for EDPC as the sphagnum peat moss plays a key role in water availability for the plant through its increased water holding capacity and aids in reducing nutrient runoff. In regard to the autoclaved and pre-used simulants used in this research, the pre-used JSC Mars-1A Regolith Simulant will provide sufficient nutrients and establish the biota needed for nitrogen fixation, solubilizing phosphorus, and the breakdown of contaminants.