Understanding the Impacts of the Deep Space Environment on Crop Production

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NASA’s goal of developing sustainable habitats to support long duration, deep space missions requires advanced science, technology, and engineering. Understanding the integrated, long-term effects of deep space environments on biological systems is needed. Sustainable habitats require the production of food and oxygen on site. Earth has a 1 “g” gravitational field, a magnetic field and an atmosphere that supports life and shields space radiation. In addition, its ecosystems are rarely “closed.” The International Space Station (ISS) orbits within the Earth’s magnetic field and has some protection from space radiation. Lunar Gateway, Lunar bases, and Mars transit vehicles will have no such protections. We need to understand how plants and their associated microbiomes respond to the absence of magnetic fields, increased space radiation, energized acoustic environments, and altered gravitational fields in enclosed facilities with limited resources. Each of these factors may act alone or in an interactive manner to produce unforeseen effects on plant or microbial growth. Understanding these factors will enable the design of crop production facilities that can sustain a human presence. It is essential that we can carry out the same experiments in different locations (ground, ISS, Gateway, Lunar surface) in the same, high fidelity manner to isolate the effects of the individual components, e.g. magnetic fields, or radiation.

NASA is assembling panels of experts in plant-microbiome interactions, ‘omics, space flight hardware, space platforms and environments and crop production to identify the major gaps in our capabilities and to outline the key science questions to address. We are seeking to understand what can be achieved on early, highly mass and power constrained missions, as well as in later missions when more resources are available.

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