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PLANT GROWTH OPTIMIZATION BY VEGETABLE PRODUCTION SYSTEM IN HI-SEAS ANALOG HABITAT

Abstract

The Vegetable Production System (Veggie) is a scientific payload designed to support plant growth under microgravity conditions. The configuration of Veggie consists of a modular plant "pillow" designed to house substrate media and time-release fertilizer, which provides each segregated plant specimen a set of specialized conditions for optimizing harvest while in low-Earth orbit (LEO). The design of Veggie affords an equal distribution of environmental conditions via the individual subsystems within the payload itself, including humidity control, passive water distribution, and controlled light emissions. Since its delivery to the International Space Station (ISS) in 2014, Veggie has undergone several experimental trials by various crews visiting the orbiting laboratory.

Ground unit testing of Veggie is being conducted during an 8-month Mars analog study in a semi-controlled environment of a simulated habitat. Taking place approximately 8,200 feet above sea level on the slopes of the Mauna Loa volcano on the Island of Hawai'i, the Hawai'i Space Exploration Analog and Simulation (HI-SEAS) offers conditions (habitat, mission, communications, etc.) explicit to a planetary exploration mission. Research using a vegetable production system designed to offer renewable food resources within a simulated Mars mission will provide 1) valuable data for conducting comparative studies with previous ground test trials and the flight units on ISS, 2) input on a proposed set of optimized design parameters to implement on active Veggie units, and 3) recommendations for utilizing the payload and overall data collected for future manned deep space missions of the solar system.

This paper provides data and analysis to show the prospect for optimization of the current Veggie design. Based on the lessons learned from legacy studies and designs, in addition to the understanding of the constraints and limitations in-place during the study, the prospect for updating the system design parameters under focus in this study may lead to improvements in growth efficiency and plant harvest

production by the payload. These results can be implemented into current Veggie experiments being conducted onboard the ISS as well as considered in the design of future payloads involving human spaceflight to deep space.