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Microgravity Experiments from Sub-Orbital to Orbital Platforms (3)

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AGRIFUGE: AN EXPLORATION OF CONTROLLED IRRIGATION METHODS FOR A ROTATING  
PLANT HABITAT**Abstract**

As humanity explores deeper into space, long duration missions will require horticulture activities to provide food, oxygen, and psychological benefits to astronauts. On-orbit horticulture allows for decreased launch mass as survival necessities are grown and produced during the mission as opposed to launching all required supplies. Additionally, tending to plants on-orbit can remind astronauts of Earth, relieving certain stresses of space isolation. This was seen during the previous VEGGIE experiments on the International Space Station (ISS). Even with the countless benefits of on-orbit horticulture, there are still many challenges that have to be solved before it can be integrated with confidence into missions. For example, the 1st VEGGIE experiments had trouble with their passive irrigation system. Our research explores a rotating horticulture enclosure that solves many of the issues encountered on previous experiments such as controlled irrigation and gravity directed growth. Rotation of the habitat provides artificial gravity within the environment. The artificial gravity can be used as an irrigation system that is tunable depending on rotation rate. Previous experiments have also used rotation as a method to remove water from roots to prevent mold. Lastly, plants such as vines, require a gravity vector to enable circumnutation in the cells, allowing them to climb. The rotating environment will allow future missions to expand their plant selection to items such as beans and pumpkins. Two versions of our device were built, a manually rotated plant habitat and an automatically rotated plant habitat. These habitats were equipped with a water reservoir, irrigation channels, and a sensor suite that could detect water flow, soil humidity, and environment motion. These experiments were then flown on a Zero-G parabolic flight to test their performance in a microgravity environment. The manually rotated habitat tested the ergonomics and a light-based signaling design to allow the astronaut to rotate the environment at a desired rotation rate. The automatically rotated environment validated the theoretical water flow rate vs rotation rate within the experiment. Results conclude that the automatically actuated rotation can achieve desired irrigation rates, providing precision and accuracy.