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"SUSTAINABLE HYDROPONIC FARMING FOR LONG DURATION SPACE MISSIONS: RESULTS FROM THE ANALOG ASTRONAUT TRAINING CENTER, EUROPE - AN ISOLATED LUNAR HABITAT SIMULATION"

Abstract

Purpose: Sustainable food production methods are crucial for extended space missions, where resources are limited and the environment is controlled. This study explored how effective a hydroponics system is for growing plants under conditions of restricted water and light in a controlled environment at Analog Astronaut Training Center, Europe, an isolated lunar habitat with elevated CO2 levels and temperature and an emergency power outage for four mission days out of total 21 mission days. Methodology: The hydroponic system in the habitat consists of an illuminated basin with nutrient-rich water, pumps, pipes, a heater, Lights, and malty illuminated planting trays, for the experiment's additional approach on growing soak and dry method to see the acceleration of Growth, with 16 hours of light and 7 hours of darkness. Water levels, quality, and CO2 levels are regularly monitored using environmental sensors, and the JBL Pro Aqua Test kit ensures optimal water conditions for healthy plant growth. Light particularly red and blue wavelengths is important for growth and development. The experiment reveals that plants flourish under these controlled lighting conditions. Water levels, light exposure, CO2 levels, and microclimate conditions were monitored. Result: The spinach plants were growing at a rate of 1 cm per day, even under limited light conditions during the Dark Mode operation in the germination stage. A detailed study of the germination survival rates highlighted the differences between plants grown with limited resources. Spinach took 7 days to sprout, Amaranthus took 4 days, while green gram plants sprouted in just 2 days. The future objective is to use a Porous Tube plant growth unit to investigate the impact of various individual growth stages, including light, temperature, microclimate, and resources. Conclusion: This research demonstrates that hydroponic farming effectively cultivates plants in a controlled environment using limited resources. Light intensity, microclimate adjustments, and nutrient management significantly influence plant growth and survival rates.