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DEVELOPMENT OF A HYPOBARIC HYDROPONIC LAB ON MARS

Abstract

In anticipation of crewed missions to Mars, a consistent and sustainable food supply must be established. Weight, volume, and cost saving measures restrict the ability to send an adequate supply of fresh food. Efficient and reliable crop growing techniques that can be practiced on Mars will drastically reduce transport costs. Fresh produce and plants will have a positive effect on the mental and physical well-being of the crew. Our team, UBC Mars Colony, is an undergraduate engineering design team at the University of British Columbia (Vancouver campus). This project commenced in the midst of the global COVID-19 pandemic and much of the development has been completed remotely with a team of 15-20 students. For the purposes of this project we are proposing a system to support a crew of 4 people on Mars for 2 years (time between launch windows). An aeroponic system was selected for minimum water usage and high growth rates. Our team is also investigating the growth of plants under low pressure. A Martian lab operating at low pressure has less structural requirements, is less prone to leaking, and uses less energy overall compared to a fully pressurized lab. Martian astronauts will be able to tend to plants at pressures as low as 30 kPa with supplemental oxygen. Preliminary studies on the growth of plants under hypobaric conditions indicate improved plant growth due to increased gaseous diffusion and decreased boundary layer resistance. More research must be done in this area to replicate previous experiments, gather data, optimize growing conditions, and to apply it on a larger scale. In response, a clear acrylic partial vacuum chamber was designed and constructed to house three plants at a time for low pressure growing experiments. Results from these tests inform the full-scale design of the Mars lab. A dedicated planting and growth schedule is included to fulfill caloric and nutritional needs of the crew with minimal supplements. Key elements of the design are prototyped and tested to validate and optimize the theoretical plans. The team meets once a week and is operating on a project budget of less than \$10,000 CAD.