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PLANTING THE SEED FOR FUTURE REMOTE TERRESTRIAL AND SPACE-BASED PLANT PRODUCTION SYSTEMS: RECENT OPERATIONS OF THE ARTHUR CLARKE MARS GREENHOUSE

Abstract

The Arthur Clarke Mars Greenhouse located on Devon Island in the Canadian High Arctic has been serving as a test-bed for remotely controlled plant production in harsh environments since 2002. In close to ten years of operations this facility has demonstrated that environment control yielding successful crop growth by remote control and autonomous mission operations can be achieved in successive years. However, it was determined that more specialized imaging systems would greatly enhance the ability to telemetrically evaluate crop health and that the environmental specifications of several nutrient solution control sensors could be further ameliorated for future extreme environment and space-based plant production systems. Since 2008, several of the greenhouse systems have been improved including an augmented greenhouse power system, a simplified nutrient control system and the further development of an imager for the assessment of plant health through remote fluorescence measurements. The project recently obtained its first successful remotely controlled spring crop. This milestone demonstrated the capacity to achieve and maintain a stable greenhouse internal environment and the ability to successfully and remotely initiate the systems required for the spring plant growth, following the long Arctic dark season. Compiled external and internal environmental data over the last two years are reported, including a description of a data management system and data analysis libraries utilized by project collaborators to analyse greenhouse environment data following download. The operational and maintenance experience gained at the Arthur Clarke Mars Greenhouse has the potential to provide valuable input to the development of future Arctic plant growth systems, including those located in remote communities or research

stations. This would help alleviate the high transportation costs presently associated with the shipment of fresh produce to the north while at the same time improving food quality and security. During plant growth phases, the Arthur Clarke Mars Greenhouse utilizes an average power draw of less than 100 W and generates its power through solar and wind sources. This off-grid, low power system implies that much of the compiled lessons learned can be also be applied to other harsh environments including hot, arid regions or other areas where infrastructure is inadequate, but where the need of fresh produce is still necessary. Several future Arctic plant production implementations are proposed including systems which utilize plants for air and water revitalization, much as they have the potential to do in biological life support systems for future long-duration crewed space exploration missions.