

PRO-MAVORS - Plant Responses in unManned VOyage gReenhouse Systems

International space agencies are developing human space exploration capabilities required to venture beyond low-Earth orbit. The Artemis Lunar Exploration Program will allow testing of these systems and operations on the Moon, in preparation for future missions to Mars. During long term, the crew will not be able to rely on constant resupply from Earth for water, food, and breathable air. Solving this problem will require the creation of Biological Life Support Systems (BLSS), where plants play a fundamental role by generating O₂, assimilating CO₂, purifying water, and producing fresh food.

To allow for sustainable and reliable plant production, plant physiologists are studying plant growth and physiology in space. The environmental stressors that will characterize orbiting stations or bases on the surface of other celestial bodies will span from altered gravity, radiations, hypomagnetic field, hypobaria, and growth in closed controlled systems. Despite the wealth of knowledge produced in the past few decades, a lot of work still needs to be done to understand the synergy between different stressors and their possible impact on crop growth and productivity. Importantly, it has been shown that in the multifactorial stress combination, even if the level of each individual stressor is below the response threshold, plant growth and survival will decline dramatically with the number and complexity of stressors involved.

The Italian Space Agency, in collaboration with 'Sapienza' University of Rome, ENEA and University of Naples 'Federico II', has developed a 3U CubeSat that was launched on-board the VEGA-C maiden flight to MEO, on a 6000-km-high highly-inclined circular orbit, on the July 13, 2022. The aim of the CubeSat, named GreenCube, was demonstrating the functionality of a CubeSat-size plant cultivation facility for the automated production of *Lepidium sativum* microgreens in MEO. The flight and ground experiments revealed a previously unpublished crosstalk between abiotic stressors.

In the **PRO-MAVORS** project, the candidate will exploit the model plant *A. thaliana* to study the interaction between different space-associated stressors. The selected researcher will be expected to set up protocols for combined stress experiments, collaboration with the other institutions involved in the project, contribute to the project by deciphering the molecular pathways at the core of multi-stressor responses. The candidate will assess changes in morphology, cell wall composition and transcriptional regulation in wild-type and selected mutant lines grown in combined simulated stress conditions.

From an applied perspective, the project will contribute to advancing the Technology Readiness Level (target TRL3) of solutions for plant cultivation in confined environments, providing experimental data and predictive models useful for the design and optimization of BLSS modules beyond LEO. The integration of biological, agronomic, and technological approaches will strengthen the link between basic research and the development of operational applications for human space exploration.