Fiscal Year:	FY 2022	**Task Last Updated:**	FY 03/28/2022
PI Name:	Schuerger, Andrew Ph.D.		
Project Title:	Microgravity Can Down-Regulate Host Resistance and thus May Up-Regulate Plant Disease Development in Space		
Division Name:	Space Biology		
Program/Discipline:			
Program/Discipline--Element/Subdiscipline:			
Joint Agency Name:		**TechPort:**	No
Human Research Program Elements:	None		
Human Research Program Risks:	None		
Space Biology Element:	(1) Plant Biology		
Space Biology Cross-Element Discipline:	None		
Space Biology Special Category:	None		
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Comments:			
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Flight Program:			
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Key Personnel Changes/Previous PI:			
COI Name (Institution):	Ferl, Robert Ph.D. (University of Florida, Gainesville) Haveman, Natasha Ph.D. (University of Florida, Gainesville) Paul, Anna-Lisa Ph.D. (University of Florida, Gainesville) Reed, David M.S. (Techshot, Inc.)		
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Task Description:	Space-faring nations are utilizing small plant-growth payloads in microgravity (micro-g) to develop the knowledge and technology infrastructures to advance the development of food production systems on other planetary bodies. As the use of small plant-growth payloads in micro-g continues, plant disease outbreaks will increase over time, once the systems are integrated into the open-air microbiomes of spacecraft. This situation presents an opportunity to address directly Section 2.3.2.B of NASA Solicitation 2020 Space Biology NNH20ZDA001N-SB E.12. Flight/Ground Research – the combined effects of various space-relevant stressors – in a manner that further enables exploration. A solid literature base exists that indicates that plant host resistance is down-regulated in micro-g and includes studies that describe decreased cell wall rigidity, cell wall thickness, cellulose and matrix polysaccharides, lignin, and altered host-resistance gene pathways in micro-g. An equally solid literature base indicates that microbial virulence may be up-regulated in microgravity and includes up-regulation of virulence in microbe/microbe, microbe/insect, and pathogen/plant interactions. However, no data exists on the interactions of a foliar phytopathogen on a plant host with concomitant host-resistance transcriptomics data. The alternative hypothesis (Ha) for the International Space Station (ISS)-flight experiment is: Microgravity Can Down-Regulate Host Resistance and thus May Up-Regulate Plant Disease Development in Space. Results will fill key knowledge gaps into how plant diseases and host resistance are affected by micro-g. Proposed here is a novel flight experiment that will study the development of a foliar plant pathogen (i.e., phytopathogen) on the well-studied, Arabidopsis thaliana (At) host. The phytopathogen – Golovinomyces cichoracearum (Gc), a powdery mildew fungus - on A. thaliana is a well-studied pathosystem. The Gc/At pathosystem is chosen here because (i) both Gc and At are sequenced and annotated, (ii) extensive literature is available on host-resistance in At, (iii) diverse At cultivars with differential expression of easily measured host resistance mechanisms are available, (iv) most stages of the Gc life-cycle are on external surfaces of leaves and can be easily observed, (v) the expected ease of sanitizing flight hardware, and (vi) maximized crew safety on the ISS because Gc has no established interaction with humans. We will use the Multi-Use Variable-Gravity Platform (MVP) facilities built by Techshot, Inc. (2 units are in orbit on the ISS) to investigate the development of Gc on leaves of At. [Ed. Note: Techshot, Inc. was acquired by Redwire Corporation in November, 2021.] Each MVP has two independently controlled centrifuge rotors fitted with up to 4 Phytofuge plant-growth modules that will be rotated at 1g or left stationary in micro-g. Each Phytofuge unit has three separate petri dishes with light-emitting diode (LED) illumination and an internal camera. Seed of three cultivars of At will be (1) sown onto growth media in independent petri dishes, (2) held dormant for up to 30 days, and (3) once in orbit, one-half of the petri dishes will be inoculated with the powdery mildew phytopathogen Gc. The aerial mycelia, conidiophores, and spores of Gc will be allowed to develop for 5-7 days and then leaves harvested for two separate research pipelines. First, half of the healthy and half of the infected At plants will be fixed in glutaraldehyde and stored at 4C until processed on the ground for fluorescent staining, Scanning Electron Microscopy (SEM), and Transmission Electron Microscopy (TEM) studies into the process of host infection. Second, the remaining healthy and infected plants will be frozen at -80C and later processed for transcriptomics of host-resistance genes. Results will inform future horticulturists, space engineers, and technologists of the risks of maintaining plant-host resistance in space when challenged by an airborne phytopathogen. The results will also assist in the design of future plant-growth modules for crewed missions to the Moon and Mars.
Rationale for HRP Directed Research:	
Research Impact/Earth Benefits:	
Task Progress:	New project for FY2022.
Bibliography Type:	Description: (Last Updated:)