| | | | |
|---|---|---|---|
| **Fiscal Year:** | FY 2023 | **Task Last Updated:** | FY 02/16/2023 |
| **PI Name:** | Baker, John Ph.D. | | |
| **Project Title:** | Determining the Impact of Space Radiation and Simulated Microgravity on Plant Root Microbial Community Composition and Function | | |
| **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) Microbiology<br>(2) Plant Biology | | |
| **Space Biology Cross-Element Discipline:** | None | | |
| **Space Biology Special Category:** | (1) Bioregenerative Life Support | | |
| **PI Email:** | jbaker@mcw.edu | **Fax:** | FY |
| **PI Organization Type:** | UNIVERSITY | **Phone:** | 414-955-8706 |
| **Organization Name:** | Medical College of Wisconsin | | |
| **PI Address 1:** | Congenital Heart Surgery | | |
| **PI Address 2:** | 8701 W Watertown Plank Rd | | |
| **PI Web Page:** | | | |
| **City:** | Milwaukee | **State:** | WI |
| **Zip Code:** | 53226-3548 | **Congressional District:** | 5 |
| **Comments:** | | | |
| **Project Type:** | GROUND | **Solicitation / Funding Source:** | 2021 Space Biology NNH21ZDA001N-SBPS E.9: Plant Studies |
| **Start Date:** | 01/01/2023 | **End Date:** | 12/31/2025 |
| **No. of Post Docs:** | | **No. of PhD Degrees:** | |
| **No. of PhD Candidates:** | | **No. of Master' Degrees:** | |
| **No. of Master's Candidates:** | | **No. of Bachelor's Degrees:** | |
| **No. of Bachelor's Candidates:** | | **Monitoring Center:** | NASA KSC |
| **Contact Monitor:** | Zhang, Ye | **Contact Phone:** | 321-861-3253 |
| **Contact Email:** | Ye.Zhang-1@nasa.gov | | |
| **Flight Program:** | | | |
| **Flight Assignment:** | | | |
| **Key Personnel Changes/Previous PI:** | | | |
| **COI Name (Institution):** | Gilroy, Simon Ph.D. ( University of Wisconsin, Madison )<br>Ané, Jean-Michel Ph.D. ( University of Wisconsin, Madison ) | | |
| **Grant/Contract No.:** | 80NSSC23K0380 | | |
| **Performance Goal No.:** | | | |
| **Performance Goal Text:** | | | |

| | |
|---|---|
| **Task Description:** | The proposed research will increase NASA's understanding of how living systems respond to environments encountered during missions beyond low-Earth orbit. While plant studies are relevant to fundamental science interests within Space Biology, the psychological and nutritional benefits of growing plants in deep space make this research valuable to the Human Research Program. All living organisms will be constantly exposed to ionizing radiation from galactic cosmic rays and intermittent exposure to solar particle events during deep space missions. Our objective is to address the likelihood of a new, potentially showstopping effect of space radiation that could have significant impact on using plants as bioregenerative life support for extended human spaceflight, i.e., the disruption of plant root microbial community structure and function. While the biological effects of charged particle radiations on mammalian systems are actively being explored, their impact on the ecological niche of plants is poorly understood. This could have substantial ramifications for crew health and psychology.<br>A visionary concept is proposed where space radiation will result in shifts in the diversity of the microbial community within the rhizosphere, preventing normal microbial function, and potentially promoting the proliferation of pathogenic soil microbiota. This concept is unexplored. Should space radiation decrease the diversity of the soil rhizosphere microbiome and microbial function, this could be a significant obstacle limiting our ability to deliver an adequate supply of food to astronauts. The studies proposed could impact extended missions; the total dose of radiation absorbed by a living organism for a Mars mission would be ~ 0.75 Sv. Total mission dose equivalent for the soil rhizosphere microbiome would be comparable. However, the impact of galactic cosmic rays on the health of the rhizosphere microbiome is unknown. Studies proposed in this application break new ground and address an unmet mission need by determining the impact of space radiation on plant root microbial community diversity and its effect on crop growth and nutritional value.<br><br>We will use a ground-based plant model approach using a spectrum of high-energy charged particle beams produced at the NASA Space Radiation Laboratory that simulates exposure to a mission-relevant dose of galactic cosmic rays. We will explore a likely significant combinatorial effect of the multiple stressors inherent in spaceflight by determining the impact of radiation and simulated microgravity on the plant and its root microbial community composition and function. We will use the 1-d clinostat as our principal ground-based microgravity analog.<br><br>The central hypothesis of this project is that space radiation disrupts plant root microbial community composition resulting in impaired microbial function.<br><br>Aim 1. Determine dose-rate effects of exposure to space radiation on plant root microbial community composition and microbial function. Arabidopsis thaliana plants inoculated with a well-characterized publicly available synthetic community of 188 bacteria, representing taxonomic and functional diversity from A. thaliana roots and soil in the natural environment, will be irradiated with a single fraction or multiple fractions of simulated galactic cosmic rays given over 1 day or 30 days resulting in a cumulative dose of 0.75 Gy.<br><br>Aim 2. Determine the combined effects of space radiation and simulated microgravity on microbiota community composition. A. thaliana will be irradiated with a single fraction exposure to 0.75 Gy of space radiation with and without simulated microgravity. Responses will be analyzed as described in Aim 1.<br><br>We have assembled a strong team comprising scientists with complementary experience in ground-based studies of space radiation on rats (Baker), plant-microbiome interactions (Ané), and spaceflight and clinostat-based analyses (Gilroy). |
| **Rationale for HRP Directed Research:** | |
| **Research Impact/Earth Benefits:** | |
| **Task Progress:** | New project for FY2023. |
| **Bibliography Type:** | Description: (Last Updated: 01/29/2024) |