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| **Fiscal Year:** | FY 2022 | **Task Last Updated:** | FY 01/04/2022 |
| **PI Name:** | Walters, Kellie Ph.D. | | |
| **Project Title:** | Modeling Leafy Greens Physiological and Biochemical Responses to Light Intensity and Successive Harvest | | |
| **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:** | (1) Bioregenerative Life Support | | |
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| **Zip Code:** | 37996 | **Congressional District:** | 2 |
| **Comments:** | | | |
| **Project Type:** | GROUND | **Solicitation / Funding Source:** | 2020 Space Biology NNH20ZDA001N-SB E.12. Flight/Ground Research |
| **Start Date:** | 10/20/2021 | **End Date:** | 10/19/2022 |
| **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:** | Massa, Gioia | **Contact Phone:** | 321-861-2938 |
| **Contact Email:** | gioia.massa@nasa.gov | | |
| **Flight Program:** | | | |
| **Flight Assignment:** | | | |
| **Key Personnel Changes/Previous PI:** | | | |
| **COI Name (Institution):** | | | |
| **Grant/Contract No.:** | 80NSSC22K0205 | | |
| **Performance Goal No.:** | | | |
| **Performance Goal Text:** | | | |

Integrating space-grown food into the astronaut diet is integral to mitigating nutrient deficiencies on long-duration flights and has been deemed a priority in the NASA Decadal Survey and the Space Biology, Plant Biology Element. Potassium, calcium, and vitamin K concentrations in stored space food may not be adequate to meet the recommended daily human intake, and compounds including vitamins B1, and C degrade over time and can become inadequate for human nutrition. For example, vitamin C concentrations of space food stored in International Space Station (ISS) conditions degraded 32 to 83% over three years. Additionally, space radiation increases the risk of cataracts, creating a need to integrate more lutein and zeaxanthin, carotenoids that potentially mitigate eye issues, into the astronaut diet. Mizuna is one of six leafy greens species to be considered for incorporation into the diet on medium- to long-duration space missions based on productivity, volume, growth pattern, mineral nutrient accumulation, and phytochemical concentrations. However, models characterizing crop physiological and biochemical responses to crop production and

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| **Task Description:** | environmental factors are needed to improve productivity and nutrient density while mitigating labor and energy resource use. Without improving productivity and nutrient density, the regular integration of fresh produce into the astronaut diet and the feasibility of long-duration space missions remains in question.<br>The long-term goal is to aid in the facilitation of long-term space missions by establishing environmental conditions and cultural factors required for optimal leafy greens growth, nutritional value, space- and energy-use efficiency, and labor by modeling crop physiological and biochemical responses. The overall objective of this proposal is to improve and quantify the consistency, phytonutrient quality, and productivity of cut-and-come-again mizuna by identifying suitable cultivars, determining the optimal light intensity and photoperiod, and quantifying changes over time in ISS-like environmental conditions (temperature of ~23°C, ~2,800 ppm $CO_2$). Specific aim 1 is to identify at least two or three mizuna cultivars with great yield and nutrient potential making them highly suitable for production in space. We hypothesize that some cultivars will produce biomass faster than others while some cultivars will have higher nutrient concentrations. Specific aim 2 is to determine the optimal light intensity and photoperiod for maximum biomass production and phytonutrient density of mizuna, creating models to predict growth and biochemical responses in ISS-like conditions. We hypothesize that yield and phytonutrient concentrations will increase as light intensity increases to a cultivar-specific optimum by increasing photosynthesis, photoreceptor mediated biochemical reactions, and beneficial stress responses. Specific aim 3 is to quantify changes in plant physiology and phytonutrient concentrations over time to identify an optimal cut-and-come-again harvesting and production protocol for mizuna. We hypothesize that as plants age, the nutrient profile and biomass production will change as well. Therefore, new seedlings may have to replace more mature cut-and-come-again plants prior to reductions in yield to maintain nutritional quality for astronaut diets.<br><br>By the completion of this study, we expect to have identified at least one high-yielding nutrient-dense mizuna cultivar highly suitable for space production. We will have the data required to calculate resource-use efficiencies to balance energy use, production duration, yield, and nutrition. We also expect to have identified how long cut-and-come-again mizuna should be grown to maximize biomass and nutrient productivity, thus improving the feasibility of long-duration space missions. |
| **Rationale for HRP Directed Research:** | |
| **Research Impact/Earth Benefits:** | |
| **Task Progress:** | New project for FY2022. |
| **Bibliography Type:** | Description: (Last Updated: ) |