Morphological and developmental variation of red mizuna grown under blue light in ground-based microgravity analogues through the utilization of specialized clinostats

Gilbert Cauthorn, PhD. Student, University of North Dakota; Richard Barker, PhD., University of Wisconsin-Madison; Christina Johnson, PhD., NASA Postdoctoral Program

Introduction

Microgreens, such as red (purple) mizuna, have been considered as spaceflight candidate crop plants to be integrated in bioregenerative life support systems for long-duration spaceflight. This is due to their high nutrient density, relatively fast developmental cycles, low horticultural energy, water needs and minimal space requirements. It is therefore important to develop space plant life-support systems capable of mitigating any potentially detrimental effects associated with crop responses to spaceflight related stressors; such as microgravity and light variation. This study focuses on identifying phenotypic variation in the development of red (purple) mizuna grown under blue light in a 2D clinostat to simulate the lack of a gravity vector found within true microgravity.

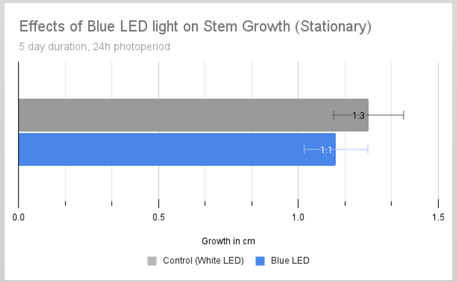

Figure 4 (*A*): Comparison of average stem growth between light treatments. P>0.05

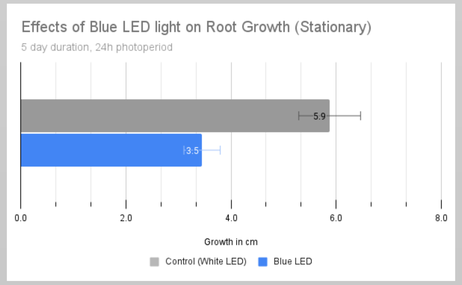

Figure 4 (*B*): Comparison of average root growth between light treatments. P<0.05

Experimental Methods

Red (Purple) Mizuna, *Brassica rapa nipponosica* , specimens were grown in square plates in un-enriched agar media for 120hrs. Control groups were grown under white LED lights (7700k/8.5ev, 24h photoperiod) while experimental groups were pretreated under blue LED lights (450nm/8.5ev, 24h photoperiod). These trials were then repeated and modified with the utilization of a specialized single axis clinostat (CoSE Gravity Chamber). Seeds grew in their respective light treatments for 72hrs before undergoing clinorotation (5rpm/48h) while under their defined light treatment for in order to simulate the microgravity environment.

Figure 1: Specimens undergoing light treatment during stationary trials. Left (Control) white LED lights, 7700k/8.5ev, 24h photoperiod; Right blue LED lights, 450nm/8.5ev, 24h photoperiod

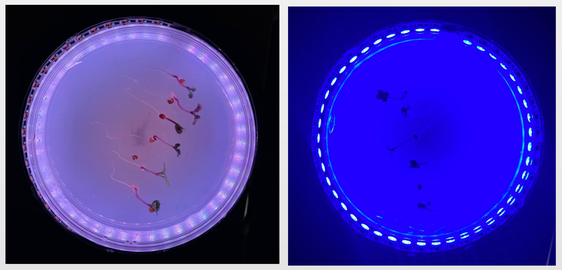

Figure 2: Red(purple) mizuna specimens undergoing 2D clinorotation at 5rpm/48hrs in order to simulate stressors associated with the microgravity environment under targeted light treatments.

Results

Uniform growth was observed in the control groups grown under white light. Specimens grown under blue light demonstrated patterns of delayed germination and overall development, with an average size difference of 35%. The most significant variation between the control and experimental groups was observed in the development of the plant root structure in the specimens grown under blue light. While undergoing clinorotation, specimens grown in the blue light treatment were on average 47% smaller than the control group specimens. The findings of this investigation suggest that the phenotypic variation in microgreens grown under blue light may be increased when exposed to microgravity stressors in the spaceflight environment. These effects may be associated with nutrient intake and density, as well as targeted dwarfing based on specified phototropic and photomorphogenic stimuli.

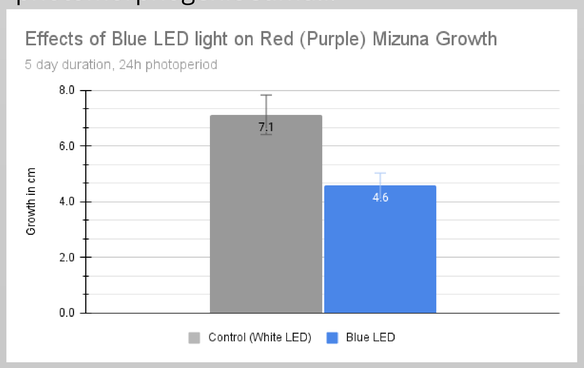

Figure 3: Comparison of average total plant growth between light treatments. P<0.05

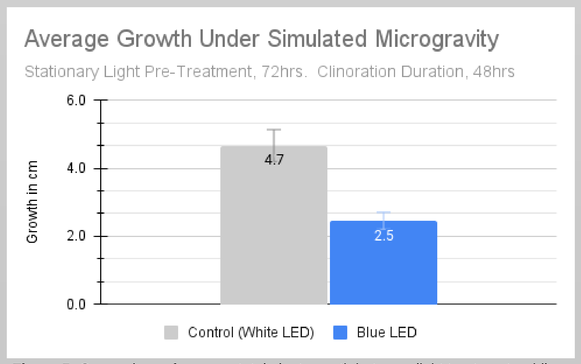

Figure 5: Comparison of average total plant growth between light treatments while undergoing clinorotation, 5rpm/48hrs. P<0.05

Conclusion and Future Goals

The utilization of blue light in the microgravity environment may be an effective method of delaying growth in red mizuna microgreens. Next step is to test green mizuna varieties to see if they follow these trends, which are contrary to previous work with *Arabidopsis.*
To build on the findings of this investigation, our team is interested in identifying the mechanisms responsible for the variation involved as well as comparing nutrient values.

Further Goals:

- Develop a baseline dataset of microgreens cultivated under varying light treatments in combination with simulated microgravity.
- Identify mechanisms capable of increasing nutrient density in microgreens while also inducing targeted dwarfing.
- Provide a non-cost prohibitive methods of conducting this kind of research to students and educators.

Astrobotany International Research Initiative (AIRI) is an open-source collaborative research platform aimed at advancing the field of space plant biology by providing accessibility to research protocols, tools, educational guidelines, and dynamic data-sets to students, educators, and researchers.
Find out more at www.astrobotany.com/AIRI

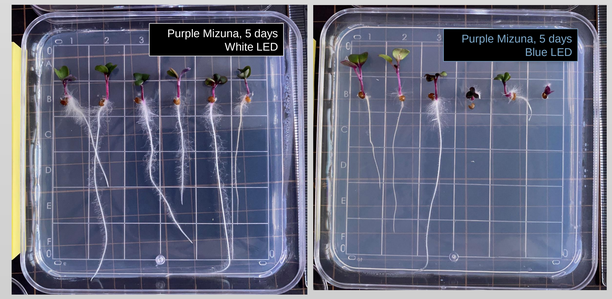

Figure 6: Selected sample of cultivars after 120 hours of targeted light treatment.

Figure 7: Selected sample of cultivars after 72 hours of targeted light treatment and 48hrs of clinorotation of targeted light treatment. Left: (Control) white LED lights, 7700k/8.5ev; Right blue LED lights, 450nm/8.5ev