NASA EPSCoR
Research Performance Progress Report (RPPR)
Seed Award

I. Collaborating Organizations

A. Academic Collaborators *(do not include names of minors)*

Name	Academic Affiliation	RID Project Role	Nearest person month worked	Contribution to Project	Funding Support
Qi Mu	University of Delaware	PI	1	Dr. Mu oversaw the entire project and ensured the smooth execution of the project	
Qingwu Meng	University of Delaware	Co-PI	1	Dr. Meng provides expertise in lightening system and environmental control needed for the project	
Jeonghwa Kim	University of Delaware	Co-PI	1	Dr. Kim provided technical support and guidance to Ms. KC.	PI Mu's Startup fund (Kim is a postdoc in Mu lab)
Shreejana K C	University of Delaware	Graduate Student	9	Ms. KC performed the project, collected the data, and generated results.	This NASA EPSCoR Seed Award and Mu's Startup fund

B. NASA Collaborators

Name	Title	NASA Center	Nature of the Collaboration

C. Industry Collaborators

Name	Title	Industry/Company Name	Nature of the Collaboration

D. New non-EPSCoR grants

Funding Entity	Award Name	Value of New Grant

E. Other Organizations Involved as Partners

Organization	Nature of the Partnership	Benefit of the Partnership

II. Products

A. List Journal publications – Please only list papers that have been published. **Please do not remove the table; or alter columns, add additional rows as required.**

Date Published	Published Paper (APA format)

B. List Conference Papers – Please only list papers that are included in conference proceeding. **Please do not remove the table; or alter columns, add additional rows as required.**

Conference Date	Conference Paper (APA format)
3/6/2025 – 3/9/2025	**KC, S., Subedi, M., Kim, J., Meng, Q., Mu, Q. (2025, March 6-9). *Optimizing maize growth in growth chambers.* 67th Annual Maize Genetics Meeting, St. Louis, MO, United States.**

C. List Conference Presentation – Please list conference presentation. **Please do not remove the table; or alter columns, add additional rows as required.**

Conference Date	Presentation Topic (APA format)
3/6/2025 – 3/9/2025	**KC, S., Subedi, M., Kim, J., Meng, Q., Mu, Q. (2025, March 6-9). *Optimizing maize growth in growth chambers.* 67th Annual Maize Genetics Meeting, St. Louis, MO, United States.**
3/5/2025 – 3/6/2025	**Mu, Q. (2025, March 5-6). *Shaping Next-Generation Resilience in Maize through Trait Discovery, Emerging Technologies, and Plasticity Mechanisms.* 2025 Corn Breeding Research Meeting, St. Louis, MO, United States.**
12/10/2024 – 12/11/2024	**Mu, Q. (2024, December 10-11). *Introducing the Molecular Plant Breeding and Genomics Lab: Current and Future Corn Research at the University of Delaware*. 2024 International Sweet Corn Development Association (ISCDA) Annual Meeting, Orlando, FL, United States.**

D. List Books and/or other Publications – Please include explanations, help us to learn about your accomplishments. **Please do not remove the table; or alter columns, add additional rows as required.**

Date	Explanations (APA format -Book, Newspaper Op-Ed, …)

E. List talk/presentation/event/outreach activity – Please include explanations, help us to learn about your accomplishments. **Please do not remove the table; or alter columns, add additional rows as required.**

Date	List talk/presentation/event/outreach activity (APA format if applicable)
12/5/2024	**KC, S., Subedi, M., Kim, J., Meng, Q., Mu, Q. (2024, December 5). *Optimizing a growth chamber system for maize production*. University of Delaware PLSC865 Research Seminar, Newark, DE, United States.**
11/20/2024	**KC, S., Subedi, M., Kim, J., Meng, Q., Mu, Q. (2024, November 20). *Establishment of a growth chamber system that supports maize growth from seeds to maturity*. CANR Student Research Symposium, Newark, DE, United States.**
9/19/2024	**KC, S., Subedi, M., Kim, J., Meng, Q., Mu, Q. (2024, September 19). *From Earth to Space: Harnessing Maize for Long-Term Sustainability*. University of Delaware PLSC865 Research Seminar, Newark, DE, United States.**

F. List of new or updated Website(s) or other Internet site(s). **Please do not remove the table; or alter columns, add additional rows as required.**

URL	Short description of purpose of site

G. Technology/Technique – **Please do not remove the table; or alter columns, add additional rows as required.**

Technology/Technique	Short description of technologies or techniques
Growth chamber maize cultivation technique	**Developed an optimized lighting system to support healthy maize growth under controlled growth chamber conditions.**

H. List patent – Please include Patent Number/Patent Title/ Patent Abstract (or link to it). **Please do not remove the table; or alter columns, add additional rows as required.**

Date Patent Issued	Patent Number/Patent Title/ Patent Abstract (or link to it)

I. List Inventions – Please include Invention Title, List of Inventor(s) and Description. **Please do not remove the table; or alter columns, add additional rows as required.**

Invention Title	List Inventor(s)	Invention Description

J. List Licenses – Please include license issued, Invention Title, List of Inventor(s) and Description. **Please do not remove the table; or alter columns, add additional rows as required.**

Date License Issued	License Assignees	License Title

K. List New/Revised Courses – Please include new/revised courses. **Please do not remove the table; or alter columns, add additional rows as required.**

Course Number	Course Name/Title	Offering Institution

L. Others: List Databases, Physical collections, Audio or video products, Software or NetWare, Models, Instruments or equipment, Data & Research Material (e.g., cell lines, DNA probes, animal models) related to your EPSCoR research. **Please do not remove the table; or alter columns, add additional rows as required.**

Accomplishments	Short Description of accomplishments

title	
Data: Maize growth and performance data under varying light intensities	**Collected comprehensive data on maize growth and physiological performance under four distinct light intensity conditions.**

III. Changes/Problems

A. Actual or anticipated problems or delays and actions or plans to resolve them

1. LED Fixture Setup and Calibration Adjustments:
To support high-light maize production, we retrofitted Conviron C-10 10-M growth chambers with Volt Grow LED lighting. While installation was completed successfully, operational issues arose in maintaining a consistent light intensity across the plant canopy during development. We conducted weekly light mapping and fixture adjustments to achieve consistent light intensities received by the plants. Additionally, the high-output LEDs increased chamber temperatures, particularly at higher intensities. Continuous fan operation was implemented to improve airflow and maintain temperature control.

2. Change in Genetic Materials:
The original research proposal outlined the use of a dwarf maize mutant with a CRISPR/Cas9-edited *br1* gene. However, due to delays in obtaining the APHIS permit for interstate movement of transgenic plant materials, we utilized a natural dwarf mutant line, R924, as an alternative. The R924 line was deemed suitable for the study to meet the research goals, as it possesses similar phenotypic characteristics to the CRISPR/Cas9 dwarf mutant, despite the underlying genetic cause of the mutant phenotype being different (R924 has a mutation in the *br2* gene). After obtaining the CRISPR/Cas9 dwarf mutant, we have included this material in two light intensity treatments conducted in the latter half of this project period. This change did not compromise the integrity of the experiment and provided equal insights into the effects of light intensities on the growth of maize genotypes as originally planned.

3. Adjustment in Experimental Design:
In the original research proposal, we outlined the use of a randomized complete block design (RCBD) with two blocks for each light intensity treatment. Each block would include six plants of each genotype, ensuring replication and accounting for environmental variability. However, due to space constraints and logistical challenges in the growth chambers, the experimental design was adjusted to a completely randomized design (CRD). This modification allowed for greater flexibility in plant placement while maintaining the integrity of the experimental setup and the validity of statistical analyses. To date, we have completed four separate experiments under all four target light intensities (400, 600, 800, and 1000 $\mu mol/m^2/s$) using the CRD approach, and have obtained significant and consistent results.

IV. Impact

Include article and photo w/caption (see instructions). Obtain permission to publish photo from any recognizable person via NASA Media Release Form. Do not include photos of minors.

With funding support from NASA EPSCoR, our team established a growth chamber system capable of growing maize from germination to maturity, as well as advancing maize environmental and space-based research. This project addresses critical challenges in confined environment agriculture, including spacecraft and extraterrestrial habitats, by generating foundational knowledge to develop standardized protocols for cultivating maize in restricted spaces.

Maize, the world's most produced crop and a resilient C4 plant, holds promise for space habitats but is constrained by its high space and light demands. To address this, we implemented genetic and environmental enhancements. We used a dwarf maize genotype to reduce plant height and space needs, and retrofitted growth chambers with high-output, energy-efficient LED lighting systems to support healthy development throughout the full life cycle of maize. To investigate the response of maize to varying light intensities, we tested four light intensities using four maize genotypes.

Our key findings include:

- **Advanced Lighting Integration:** Installing energy-efficient LED fixtures provided the necessary light intensity for maize growth from germination to maturity within confined chambers.
- **Genetic Optimization:** Using a dwarf maize mutant allowed for reduced spatial requirements without compromising plant health, enabling effective cultivation in limited spaces.
- **Phenotypic Performance:** Both normal-height and dwarf maize genotypes thrived under the tested light conditions and exhibited varied growth patterns under two light intensities.

The project enhanced the physical infrastructure at UD by enhancing growth chamber capabilities with state-of-the-art LED lighting. We established a robust platform to facilitate the maize life cycle in growth chambers, enabling both fundamental and applied research. By testing regular and dwarf genotypes across a light intensity gradient (400 to 1000 $\mu mol/m^2/s$), we generated valuable developmental and physiological data. Our findings also suggest that 500 $\mu mol/m^2/s$ is the optimal light intensity for maize growth in confined chambers, contributing to the knowledge base for extraterrestrial crop production. Ongoing efforts focus on uncovering the mechanisms underlying maize–light interactions.

Our controlled environment system with an improved lighting system allows maize to grow from seeds to full maturity. Dwarf genotype is shown in the image.