PennState College of Education | CSATS Center for Science and the Schools

Research Experiences for Teachers

VPSR | PennState Harrisburg | NSF

Investigating the Biological Effects of Space Exposure on Tomato Seed Development: A Morphological to Molecular Approach

Kerri Rapp[1], Evan Schwan[2], Suhaas Sontyana[3], Dr. Jessica Dobrin[4], Aaruhi Jairath[5], Dr. Shobha Rudrabhatla[6], Dr. Sairam Rudrabhatla[7]

[1]St. Theresa School, [2]Penn State Harrisburg Biofuels Lab,[3]Carnegie Mellon University, [4]Mercersburg Academy, [5]Hershey High School, [6]Vytal Plant Science Research, [7]Penn State Harrisburg Biofuels Lab

Abstract

The aim of this experiment was to determine if microgravity impacts the morphological and physiological characteristics of Lycoperscion esculentum, commonly referred to as Roma tomatoes. As humans expand space exploration further from Earth, the ability to grow a supplemental food crop is necessary to address the challenge of long duration missions.

The Tomatosphere™ project sent Heinz 1161F1 (Roma) seeds into space in 2024 for 8 weeks aboard the International Space Station (ISS) while a control group remained on Earth. The seeds were germinated in May 2025 (Fig.1A), transplanted into pots in June 2025 (Fig. 1B) and grown in a greenhouse. Plants were measured for height, chlorophyll content, stem diameter, date to flower, date to fruiting and carotenoid absorbency.

Materials and Methods

Fig. 1

A. Seeds germinated in peat pellets B. Seedling transplanted into a larger pot with 864 g soil C. Plant height (cm) recorded weekly D. 1 cm leaf discs from nodes 5,6,7 were with mixed 80% acetone prior to being macerated for chlorophyll extraction. E. Chlorophyll samples in cuvettes F. Roma tomato from July 28.

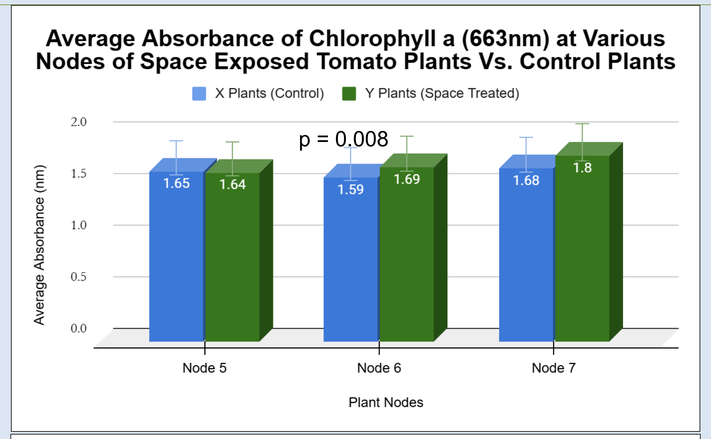

Fig. 2

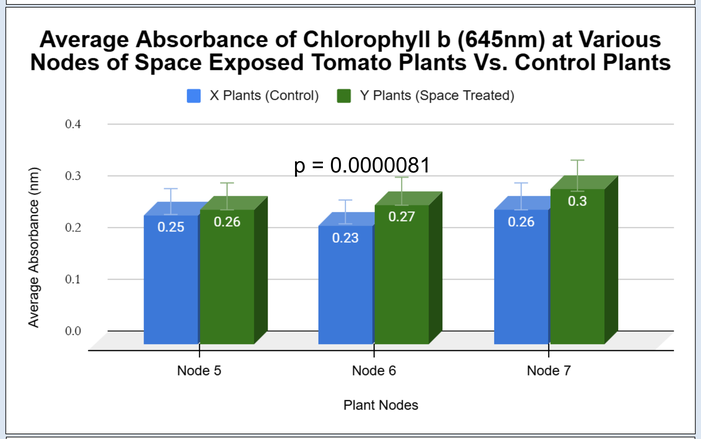

Fig. 3

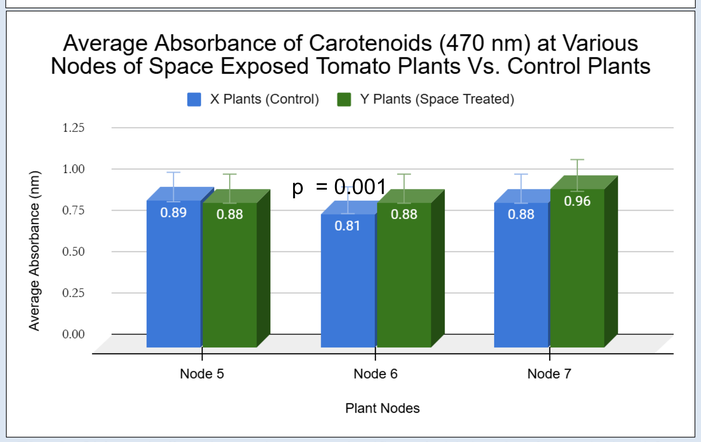

Fig. 4

Fig. 2. Chlorophyll *a* absorption was significantly higher in plants derived from space-exposed seeds compared to Earth controls.
Fig. 3. Chlorophyll *b* content was elevated in space-treated plants relative to the control group.
Fig. 4. Carotenoid levels were greater in plants grown from space-treated seeds than in controls.
Fig. 5. Plants from space-treated seeds exhibited increased height compared to control plants.
Fig. 6 Image depicts morphological, developmental and physiological differences.
Fig. 7. Stem diameter was larger in space-treated plants than in controls.
Fig. 8. Space-treated plants initiated flowering earlier than control plants.

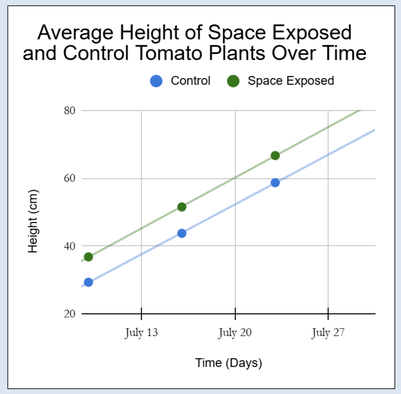

Fig. 5

Fig. 6

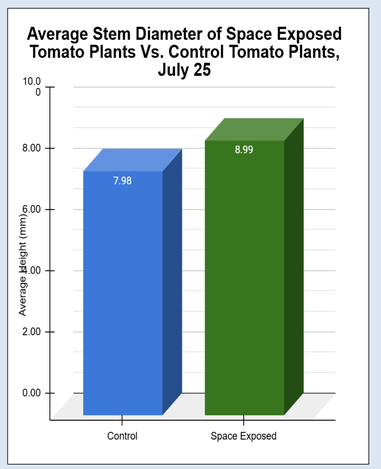

Fig. 7

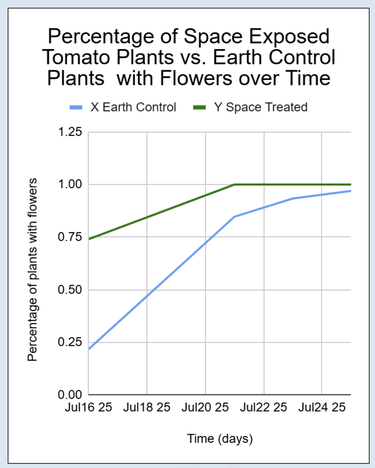

Fig. 8

Results & Conclusions

Roma tomato plants grown from space-treated seeds exhibited several notable differences compared to the control group. These plants grew taller, flowered earlier, and developed thicker stems. They also showed elevated pigment levels, including increased absorption of chlorophyll *a* and chlorophyll *b*, as well as higher carotenoid content. Additionally, space-treated plants reached the fruiting stage more quickly than those grown from Earth-based seeds. The results support previous studies that show microgravity can affect auxin distribution, leading to thicker stems as well as causing stress responses which affect growth, due to an increase in cell division.

Acknowledgements

My sincere gratitude to Dr. Sairam Rudrabhatla (Penn State Harrisburg Biofuels Lab) and Dr. Shobha Rudrabhatla (Vytal Plant Science Research) for their invaluable guidance and steadfast support throughout this project. Thank you to Evan Schwan and Dr. Jessica Dobrin for their collaborative contributions and readiness to assist wherever needed

The RET for Teachers is funded by the National Science Foundation Grant DBI-2341402.