NASA KSC/Intern Abstract – Summer 2018

Plant Growth Research for Future Food Production

Seed Microbiome Project

Student Name: Eva Birtell
Academic Level: Junior
Academic Major: Environmental Horticulture, Soil & Crop Science, Biotechnology Minor
Academic Institution: University of Wisconsin – Platteville

Mentor Name: Anna Maria Ruby
Mentor Job Title: AST, AEROSPACE FLIGHT SYSTEMS
Org Code/Branch: UB-A
Division: Utilization & Life Sciences Office
Directorate: Exploration Research & Technology Programs

1.0 Abstract

Humanity is currently on the precipice of a new era: one where human civilization is no longer bound to the confines of a single planet. Now, organizations like the National Aeronautics and Space Administration (NASA) have extended their areas of research and are beginning to focus not just on getting humans into space, but also to keep them safe, healthy, and sane. This focus falls under the Human Research Program (HRP). A focus of this program is "dedicated to discovering the best methods and technologies to support safe, productive human space travel" [1]. For "safe and productive space travel" to occur, astronauts must have proper nutrition [1]. While sending up large amounts of dried and packaged food with every shuttle might work fairly well in the short term, when only a few people need to be fed, it will not be sustainable, especially as NASA looks toward longer space journeys beyond the Earth's orbit. Research into this area falls under Advanced Life Support (ALS), whose mission is to develop regenerative life support systems to support future NASA long-duration missions [2]. This would involve growing crops in space to supplement astronaut diets [2]. An important, yet often overlooked, part of growing crops in any environment is the microbial organisms that inhabit the plants' microbiomes. The *Seed Microbiome Project* aims to investigate the microbial presence throughout the life stages of three crops, Mizuna Mustard, 'Outredgeous' Red Romaine Lettuce, and 'Red Robin' Tomato, that have either been or will be grown on the ISS [3].

Through this investigation, researchers will characterize the microbiome and have a greater understanding of the microbes, their pathogen potential, and their role in the plant's microbiome. Eventually this information will be used to create biological primers consisting of beneficial bacteria that could promote plant growth and outcompete pathogens, thereby protecting astronauts from potential food-borne illnesses.

It takes a substantial amount of preparation before the microbiome of a plant can be sampled and analyzed. Part of this experiment was to see how the microbiomes of sanitized versus unsanitized seeds compared, so half of the seeds had to be sanitized, while the other half remained as they came in the package. Then, the chambers that the seeds were to be grown in had to be sanitized, with the objective of preventing as much outside contamination as possible. Likewise, the media the seeds would be grown in, arcilite, had to be sterilized using an autoclave, and the 4-inch pots,

pot-liners, and fertilizer had to be as sterile as possible as well [3]. Once everything was sterile or sanitized as best as possible, the seeds were planted and "grown in a Percival chamber at 23°C, standard fluorescent lights for a 16h/8h light/dark cycle. Relative humidity will be maintained at approximately 50% and CO_2 will be set at 3000 ppm. Watering will be set as an automatic system" [3]. With these measures in place, the chamber has been monitored daily to watch for fluctuations beyond the set amounts. Also, data has been recorded as the seeds germinated and continued to develop into mature plants.

Every seven days after the day of planting, three of the plant samples of sanitized and unsanitized 'Outredgeous' lettuce and Mizuna Mustard are harvested. Plants samples are chosen for harvest based on size, the biggest plants being selected first, that way giving some of the smaller plants a chance to catch up. After being selected, samples are photographed, and the plant's dimensions are recorded. Then, the leaves and stems are removed from the root, and the above ground portion is cut into smaller pieces and placed in a 50 ml tube with sterile water and beads before being weighed and sent over to the microbiology lab [3]. The same happens with the roots after they are dug out of the media.

Once over in the microbiology lab, the samples are shaken, the beads in the test tube break down the plant cell walls and stir up and expose the microbes that had previously been sheltered within the confines of the plant tissue. This slurry of plant tissue and water is then diluted to lower the overall concentration of microbes. The diluted plant microbes are then deposited on to petri dishes and incubated. After that the microbes are counted and identified using PCR and genomic sequencing [3].

The final aspect of this project is the literature research. Once species have been identified, the next step is to find out what they are doing within the plant. There have been many papers written about a wide variety of microbes, and that data needs to be sifted through for each identified microbe, so that when finished, there will not be just an overwhelming list of identified species. Instead, an ecosystem will be mapped out describing the roles that each microbe plays in the plant microbiome. Eventually, this data will not just assist in creating ecological maps, but will also give future research opportunities to modify the plant microbiomes to suit the rigors of space travel.

Works Cited

[1] B. Dunbar and K. Mars, "About HRP," NASA, 11 June 2018. [Online]. Available: https://www.nasa.gov/hrp/about. [Accessed 10 July 2018].

[2] M. Perchonok, "Advanced Food Technology Workshop Report, Volume I," NASA-Lyndon B. Johnson Space Center, Houston, TX, 2003.

[3] C. Khodadad and J. D. Taylor, "Seed Microbiome Test Plan," Engineering Services Contract, Kennedy Space Center, FL, 2018.

[4] R. Wheeler, G. Massa and M. Hummerick, "Baseline Microbial Assessment of Fresh Produce," Kennedy Space Center, FL, 2018.