**TEST EQUIPMENT DATA PACKAGE**

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***The Effects of Microgravity and Light Wavelength on plant growth in an Ardulab***

TEDP Completion Date:

**IMPORTANT THINGS TO NOTE:**

**Avoid permanent magnets if possible**

**Avoid Shaterable materials if possible (e.g. class) However there are ways to secure these items, just be sure Mentor and NanoRacks are aware so that they can be packaged appropriately.**

**Avoid pressure vessels**

**Avoid substances with toxicity higher than 2 on MSDS’s**

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| **Doc. Version** | **Date** | **Description** | **Page No.** | **Change Authority** |
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**QUICK REFERENCE DATA SHEET**

Team Name:

Principal Investigator:

Contact Information:

Experiment Title:

Work Breakdown Structure (WBS):

Flight Date(s):

Overall Assembly Weight (lbs):

Assembly Dimensions (L x W x H):

Equipment Orientation Requests in reference to NanoRack:

Proposed Mounting to NanoRack:

Does Experiment need to be located next to fan on NanoRack: (Yes or No)

Power Requirement (Voltage 9and Current Required):

Camera or Video Requested? (Yes or No):

**TABLE OF CONTENTS**

Section\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_Page Number

Change Page

Quick Reference Sheet

Basic Mission Objective

Experiment Background

Experiment Description

Operational Scenario

Equipment Description

Electrical Analysis

Institutional Review Board Information

Hazard Analysis

Tool Requirements

Photo Requirements

Hazardous Material

Material Safety Data Sheets (MSDS)

Experimental Procedures Documentation

Bibliography

Deviations/Exceptions/Waivers

**BASIC MISSION OBJECTIVE:**

*Technology demonstration, research, Proof of concept?*

This experiment will test the effect of combinations of red and blue wavelengths of electromagnetic radiation on a small fast growing plant such as pea or broccoli shoots. We can start these plants from seeds and they will be placed in a 10 cubic centimeter Ardulab and grown in a microgravity environment.

This experiment will be important so that plants with high nutrition can be effectively and rapidly grown on the ISS and on future long duration flight. We propose to identify the combination red and blue LEDs that will induce the most rapid growth.

**EXPERIMENT BACKGROUND**

*Why is this experiment relevant?  What questions will it answer? Include NASA supporting org. and programs and research history.*

The selection process for a nutritional, rapidly growing plant that could be easily grown from seeds led us to three vegetables commonly eaten as shoots. In their early stages of life, peas, popcorn shoots, and bamboo could be used as test subjects to observe the speed of growth under different wavelengths of light. Pea shoots contain high amounts of Vitamin A, B, C, E, calcium, chlorophyll, iron, magnesium, niacin, phosphorus, potassium, amino acids, and protein up to 25%. In additional to their nutritional values, they are also low in sodium, fat, and sugar. They can be harvested after only two to four weeks of growth, and have a seed shelf life of four to five years. Popcorn shoots also contain Vitamin A, B, C, E, calcium, chlorophyll, iron, lecithin, magnesium, pantothenic acid, phosphorus, potassium, trace elements, and around 30% protein. However, popcorn seeds only take between eight to twelve days to sprout. In addition to pea and popcorn shoots, bamboo shoots are also highly beneficial. Studies show that bamboo can prevent the production of cancerous cells, improve appetite and digestion, aid weight loss, and treat hypertension and hyperglycemia. The main nutrients include high levels of protein, amino acids, healthy fats and sugars, salt, and water contents.

We are planning to use a combination of red and blue LED lights. According to our research, a mixture of red and blue lights provides the optimal wavelength to induce favorable plant growth.

Professor Allen Barker at University of Massachusetts Amherst stated that 450 and 650 nanometers are required for photosynthesis, and red light has wavelengths between 622 and 780 nm. Blue light has between 455 to 492 nm, and violet light has between 390 and 455 nm. Also between 650 and 730 nm wavelengths allow the plant to flower by influencing the phytochrome plant pigment.

NASA has used white, green, and red lights in the past; this is one of the reasons we have decided on these colors. Red LED lights have been proven by NASA to cause the plants to have a “higher concentration of anthocyanin, an antioxidant that can combat some of the effects of cosmic radiation” (LED Lights Used in Plant Growth Experiments for Deep Space Missions). Another NASA study concluded that green lights are also beneficial to plants. NASA believes the light is important because of the positive effects, like an increase of antioxidants, can have on the plants.

A space experiment called VEGGIE, short for plant growing system about the size of a microwave oven, to be sent onto the ISS on Dec. 9 2013. The experiment called for red and blue LED lights for photosynthesis to take place and to make experiments. LED lights are being used because of their long lifetime.

From October 2009 to September 2010, scientists grew a garden of thale cress on ISS in an experiment called ADSVAC, which tested the Advanced Astroculture Plant Growth Chamber.  Scientists genetically modified these plants to under how stress in a zero gravity environment was affecting the plants. When they genetically modified the plants, it allowed them to glow when they were unhappy. This was helpful because it meant they could examine the plant without dissecting it.

 Seeds in space followed the same sprouting pattern and growth stages as the plants here on Earth. Many scientist were concerned that the roots would grow incorrectly because it was thought that gravity had an effect on the downward formation of the roots. After NASA had conducted a successful experiment on the international space station, it is known that gravity is not necessary to growing plants.

In 2010, the ISS was sent plants called *Arabidopsis thaliana* or Thale Cress. These plants were used to study how plant roots developed in a weightless environment. These plants were grown on a nutrient-rich gel in clear petri plates. These plants showed familiar root growth patterns where roots slant progressively as they branch out. Researchers have always thought that direction of growth was the result of gravity's effects on root tip growth. Others think that in microgravity, other factors take over that enable the plant to direct its roots away from the seed and light-seeking shoot. Those factors could include moisture, nutrients, and light.

A study was done at the University of Wisconsin and at Kennedy Space center growing wheat plants with only red lights. The plants were dying, thin, and very "pale" because of the loss of chlorophyll.  Blue fluorescent lights repaired most of the problems caused by the blue LEDS.  In the September of 2012 NASA ran and experiment monitoring the growth of radish plants versus red leafed lettuce and in different types of lights and light levels. A chlorophyll meter was used to measure the amount of chlorophyll in a plant. Afterwards, the plants were frozen in liquid nitrogen and were pulverized into a new powdery form. The powder would be used to run a new test in which the amount of stored energy in the plant tissue would be measured. The plants were grown in red, blue, white, and green LED lights. Some lights increase nutrients and antioxidant. The lettuce and radishes showed darker red color under the red and blue LED lights, some nutrients found in red leafed lettuce thrived in the red light. Some of these nutrients fight cosmic radiation. Ongoing experiments are currently further investigating the topic.

**References**

Barker, Allen. “Laboratory Manual: Experiment 11.” *University of Massachusetts*.Web.3

            Oct.2013

Cobb, Bruce. "Golden Sweet Pea Tendrils and Corn Shoots.” Web. 2 Oct. 2013.

"Easy breakfast (with shoots!)." (2012)Web. 2 Oct. 2013.

Herridge, Linda. “LED Lights Used in Plant Growth Experiments for Deep Space Missions.”

*NASA's John F. Kennedy Space Center:* 1. *NASA.* Web. 26 September. 2013.

"How to Grow Pea Shoots Quickly and Cheaply." (2013): Web. 2 Oct. 2013.

James Owen. “Plants Grow Fine Without Gravity” *National Geographic News*. Web. 2 October

2013

Jones, Farmer Lee. "Popcorn Shoots."  *Popcorn Shoots*.2013. Web. 2 Oct. 2013.

"The nutritional benefits of eating bamboo shoots." Web. 2 Oct. 2013.

“Plants in Space” *Nasa*. Web. 1 October 2013

“Wavelengths for the various colors.” Web.3 Oct.2013.

Wells, Robert. “Plants in Space: No Gravity Required.” *Futurity*. Web.  2 October 2013

“Why Study Plants?” *Nasa*. Web. October 1 2013

**EXPERIMENT DESCRIPTION**

*Brief explanation of experiment. Include sketches or AUTOCAD ipt files*