Pots and Pillows:
Growing Potatoes In Lunar Regolith Soil

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Team Number: 12431

Challenge Division: High School Category

Challenge Identifier: Plant the Moon
**Background:**

With the goal of establishing a semi-permanent base on the Moon in the mid 2020s having been firmly established by the National Aeronautics and Space Administration (NASA), tackling the problems posed by long-term space travel and inhabiting a foreign celestial body has risen to the forefront of the engineering community. A key factor in the accomplishment of this goal is the successful cultivation of crops in a lunar environment, since it is impracticable to transport all the food and water necessary for such a mission all at once and a base would ideally be self-sufficient. With this in mind, it is logical that any crop grown on such a base should be as calorie dense and resilient as possible. The most obvious choice for this crop has been the potato, since it fulfills both of the aforementioned criteria as well as being relatively easy to grow. Therefore, this study will focus on the viability of growing potatoes in lunar soil. Preliminary research indicated that traditional farming methods used on Earth wouldn’t necessarily translate to other planets or celestial objects. One of the major issues was providing the plants with an adequate environment to grow in that could properly simulate the growing conditions on the moon, including low-gravity simulation. A possible solution offered by the compilation of sources was growing them in pillows, which was identified as an enticing possibility to explore further.

**Experimental Parameters:**

The experimental design will focus on comparing the effects of growing red norland seed potatoes (*Solanum tuberosum*) using two different methods: the traditional farmer’s method, and the astronaut’s method. The farmer’s method involves planting the potatoes in simple pots, while the astronaut’s method uses specially designed pillows, inspired by current research and
experimentation done at the Kennedy Space Center, specifically the Veg-03 Plant Pillows. Several aspects of the experiment would have to be held constant in order to properly collect results, including the ratio of lunar regolith to soil, the volume of the soil mixture, and light exposure schedule the plants will undergo. There would also have to be a difference in the water-deliverance system, because the potato-pot plants will be watered by hand while the potato-pillow plants will receive their own water through an absorption system. Because of the pillow makeup, the pillows were initially assumed to have an autonomous absorption system, although it became evident that it was necessary to supply the pillows with fresh wicking water on a biweekly basis.

The team will grow a total of four plants — two in pots and two in pillows. There will be the same amount of soil in both methods — with congruent soil composition (50% Miracle Gro and 50% lunar regolith) and volume (1,745 cm³ each). After planting, the potatoes will grow under blue and red LED grow lights turned on for 12 hours and then turned off for 12 hours with a timer. For the first 40-60 days of the growth period, all plants will grow under blue LED lights, for it is the best for seedlings. From then on, they will grow under red and blue LEDs, for the combination is notorious for the “fruiting” of plants and the growth of roots, respectively. Each pot will contain one seeding potato that will sprout into a potato plant. The pots will be set in a square formation with a UV lamp with four arms in the middle, which will distribute light equally to each of the pots containing the plants. The pot-plants will be watered manually with 0.45 gallons of water each pot every 4-5 days.

Pillows have a precise formation. The intended steps to create these pillows after mixing fertilizer and regolith is as follows: After laying out and sealing two ends of monokote to create a bag approximately 34 cm by 24 cm by 8 cm, the simulant, or the fertilizer-regolith mixture, will
be inserted into the bag, which will then be sealed completely using a heat seal device. Poking four holes into the bottom of the pillow, four plastic tubes (with a cotton twine wound within them for water absorption) will be inserted into the pillow and then fed through four similar holes cut into a Tupperware lid. After filling the Tupperware container with water, the lid will be placed back on with the pillow on top, and finally, a slit will be created at the top of the bag to insert the potato. With the cotton twine in the plastic tubing hydrating the simulant and the potato itself with the Tupperware container being its water source, the pillow dynamic as a whole would be autonomous. The Tupperware lid would be removed to add more water whenever needed, or to change out the water that had become muddy due to the soil for clean water.

**Hypothesis:**

If red norland seed potatoes are grown in plant pillows — a more structured mechanism — compared to the traditional plant-in-pot method, then it will produce the greatest plant growth out of the two methods

**Independent Variable:**

The independent variable would be the growing method, i.e. whether the potato was grown in a pot or a pillow.

**Dependent Variable:**

The dependent variable in this experiment was the height of the potato plants, as well as the appropriate yield of newly grown potatoes.
**Controls:**

In order to isolate the effects of the independent variable, the ratio of lunar regolith to soil, the volume of the soil mixture, and light exposure schedule the plants will undergo will be kept constant between the potted and pillow plants.

**Measurements & Procedures:**

Plant health will be monitored through qualitative data from roots and sprouts. The steps of measuring plant health, whether that be through roots or sprouts, may differ between the pot plants and pillow plants, due to the visual obstruction of their makeup. However, terminal success is determined through quality and quantity.

During the experiment, the team decided to make the primary recording method the vertical growth measurements relative to the surface of the soil in order to monitor the growth as accurately as possible. The reasoning behind this method lies in the issue that the team would not be able to measure based on the yield of the actual potatoes until the experiment was over. Although the measuring schedule was troublesome to organize at first due to our absence over extended periods, the team ultimately measured approximately every 7 days. Prior to this decision, which took place on 2/27, the team would aim to measure every 4-5 days depending on the availability of access to the plants. Two members of the team would measure the distance from the top of the plant to the surface of the soil and then record the individual data for each plant.
Results:

<table>
<thead>
<tr>
<th>DAY</th>
<th>PILLOW 1</th>
<th>PILLOW 2</th>
<th>POT 1</th>
<th>POT 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>02/16: Planting Day (Day 1)</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>02/27 (Day 11)</td>
<td>4.5 cm</td>
<td>5 cm</td>
<td>7.5 cm</td>
<td>12 cm</td>
</tr>
<tr>
<td>03/06 (Day 18)</td>
<td>15 cm</td>
<td>10.5 cm</td>
<td>22 cm</td>
<td>30.5 cm</td>
</tr>
<tr>
<td>03/14 (Day 26)</td>
<td>40.5 cm</td>
<td>34 cm</td>
<td>56.5 cm</td>
<td>53 cm</td>
</tr>
<tr>
<td>03/31 (Day 43)</td>
<td>70 cm</td>
<td>70 cm</td>
<td>72 cm</td>
<td>69 cm</td>
</tr>
</tbody>
</table>

Discussion & Conclusions:

While the team did not grow any additional potatoes, their quantitative data lies in the potato sprouts and its exponential growth in what the team perceives to be a short amount of
time. We can conclude that, although the pillow method of growing potatoes has a circuitous, and therefore, presumably more effective way of growing our selected crop, there is no quantitative difference between the two aforementioned methods; however, what can be concluded as effective were the proportions of the lunar regolith and the MiracleGro fertilizer to grow the potatoes. We assume there was too much water that the potatoes were absorbing and too little space for the potatoes to grow, so if we were to go about this experiment differently, we would choose a much smaller crop that would compensate for the limited space to grow as well as prosper with the large amounts of water absorption.