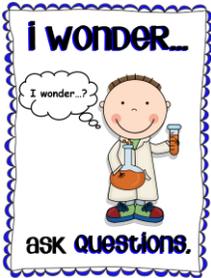


Title: Planting Green Beans on the Moon!

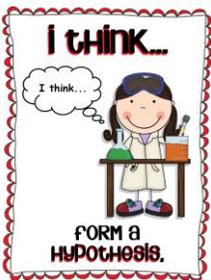
We learned a lot during our plant the moon challenge, and we earned some badges on the way. First we earned our “Space Science Adventurer” badge by learning about space and what the environment is like on the moon. Then we earned our “Think Like a Citizen Scientist” journey by learning about how plants grow and designing our experiment.



Questions We Asked:

- **What to plants need to grow (here on earth)?**
- **What do we know about the moon?**

We learned that plants need nutrients to grow (Nitrogen, Phosphorous and Potassium). The ground on the moon doesn't have a lot of that, so we have to add it in. We learned about a number of different additives gardeners on earth use – some add nutrients to the soil (like bat guano and worm castings) while others don't add any nutrients but do have other benefits, like helping to retain water (volcanic ash) or helping the roots absorb the nutrients around them (mycorrhizal fungi). So, we decided to test and see what combinations of nutrient and non-nutrient additives grow the best plants. We also decided to grow green beans because they're delicious.



What We Thought Would Happen:

We think adding nutrients to the soil from bat guano and worm castings will make the plants grow. (Worm castings might do the best because worms here on earth add lots of nutrients to the soil and are really good to have in a garden.)

Adding more additives (volcanic ash and mycorrhizal fungi) that do other beneficial things might make the plants grow even better. But, they probably won't grow anything on their own because they don't really give the plant the Nitrogen, Phosphorous and Potassium it needs.



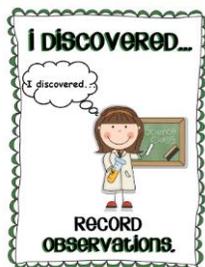
Our Experiment Design: We mixed the lunar soil with different additives.

- **Independent Variables:** Bat Guano, Worm Castings, Perlite, Mycorrhizal fungi
- **Dependent Variables:** We realized pretty fast that we had more dependent variables than we expected. The different soil mixtures absorbed water at different rates so we couldn't water all the plants with the same amount or at the same times. Some of them looked like they were drowning. It was too much water sometimes. We had to wait for the soil mix to be ready.

We also had to change how long we left the lights on for. If watered the plants too much, we had to leave the lights on longer to help them drink more water.

- **Controls:** All the plants got the same amounts of additives and soil. All the plants stayed in the same location with the same room temperature and humidity. All the plants got distilled water.
- **Measurements:** We measured the height of the plant, counted the beans, checked the humidity and measured the pH.

Pot	Soil	Amendments	Crop
1 (control)	Lunar Regolith	• None	Green beans
2	Lunar Regolith	• Bat Guano	Green beans
3	Lunar Regolith	• Worm Castings	Green beans
4	Lunar Regolith	• Bat Guano + Perlite	Green beans
5 (if applicable)	Lunar Regolith	• Worm Castings + Perlite	Green beans
6 (if applicable)	Lunar Regolith	• Bat Guano + Mycorrhizal fungi	Green beans
7 (if applicable)	Lunar Regolith	• Worm Castings + Mycorrhizal fungi	Green beans
8 (if applicable)	Miracle Grow Potting Soil	• None	Green beans



Our Results:

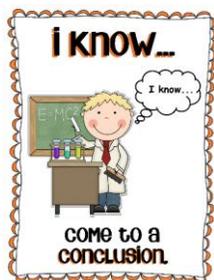
We tried to keep a lab notebook, but it didn't work so well. We had to replot three of our plants because they grew too big and needed more space. It changed our measurements a lot since the plants were deeper in the soil and some of the stems broke.

We did make some good observations though. Things we learned:

- We learned that green beans will grow in 100% lunar soil. Although the harvest wasn't big. We only grew one bean. Still, it was the best harvest we had. The other plants didn't grow any.
- The plant that was the biggest and healthiest was plant #5 (worm castings and perlite). It had the tallest and healthiest stem and the biggest leaves – even better than pot #8 (Miracle Grow). But it didn't grow any beans.
- Some plants either didn't grow at all, or they only grew a few centimeters (like 3 or 4 cm) and died. One thing all these plants had in common was that their soil was really dense. It was hard – like concrete. We don't think the roots could push through. The plants that did grow (#1, #5 and #8) had very loose soil. We think the roots could get through easier.

- **See all our photos here:**

https://www.dropbox.com/sh/jwwv13o5aq0t7o8/AABH32xUM_G5ZWTURg2PA8Sta?dl=0



Our Conclusion:

We learned a term called aeration. We know now that it helps loosen the soil. We think that the heavy additives like bat guano were too dense when mixed with lunar soil. So dense that even adding Perlite didn't help. The worm castings must be a bit lighter. Even though pure worm castings + lunar soil was too dense – adding the perlite gave it enough aeration for the roots to break through. For future experiments, we might want to look at ways to make the soil lighter and more airy.

Other Notes about Our Journey:

Also, during our experiment learned about pH and how to measure it using pH strips. We had lots of fun measuring the different soil mixtures (which all seemed to have a neutral pH) and comparing it to other things like orange juice, tooth paste, Coca-Cola, vinegar and baking soda.

Check out our pH video: <https://vimeo.com/635679613/5354ac1ade>

We also worked on our engineering skills. We built a greenhouse out of zip lock bags, duct tape and straws. (It had to be reinforced with wooden sticks because it kept falling over.)