Hydroponics: Ditch The Dirt

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Abstract

This project is about hydroponics. Hydroponics is a very important way of growing plants, and can help people acquire fresh produce when the land is not fit for growing. We like the idea of being able to help people in need, which is why we chose this topic. “We can develop a suitable growth media from plants out of recycled materials found in the classroom.” Was the project hypothesis. To prove this hypothesis, we performed three, ten-day growth cycles of commonly used growth media; vermiculite, water beads, peat moss, and gro-block. We placed these media’s into 3D printed pods that would suspend the media and seeds into water mixed with a growth solution. We printed 100 pods, and each media had 25 pods per growth cycle. We grew plants in these commonly used media’s so that we may compare the successfulness of these media’s to the media we created. How many plants grew determined the successfulness. After the three growth cycles, we conducted another cycle that had 75 pods containing the growth media we created, which consisted of shredded paper, pencil shavings, used brown paper towels, and cardboard from shipping boxes and tissue boxes. At the end of the experiment, our own growth media had 77% plants grow, and the other medias had around 80% grow overall, which proved that our hypothesis was correct. We learned that we can make our own growth media, and that it can be sustainable in growing plants.

Hydroponics Garden

Introduction

Hydroponics is an innovative and efficient way to grow plants without using any soil. Plants grown in a hydroponics system do not need to get nutrition from soil since the roots are submerged in a nutrient rich water that can help the plants grow up to 25% faster. Though the roots are in the water, the rest of the plant is in the air. This allows them to get the light and oxygen they need. Hydroponics systems can vary in size, chemical composition, and the types of plants grown in them. However, one thing many systems have in common is that they are easy to control. You can manipulate the type of water, the chemical solution, and the bedding type. Most plants are able to grow in a hydroponics system, but the most common type of plants grown are lettuce, tomatoes, and spinach. Since suitable growing land is decreasing, it is imperative that we have new ways to grow food. Because the plants grow in a tank, hydroponic systems can be virtually anywhere, since the stipulations of needing good soil are no longer there. This makes hydroponics very valuable to our world, and is why we chose to do it as our Science Fair.

Background

What is Hydroponics?

Hydroponics is a way to grow plants without using a lot of space or any soil. The plant's roots in a hydroponic system are submerged in nutrient rich water, while the rest of the plant is exposed to air. Usually a system will consist of a reservoir, nutrient pump, timer, air pump and stone, and a grow bed. The most common type of plants grown in a hydroponics system are leafy plants such as lettuce or spinach.

Why Hydroponics?

While humans push forward into the world, they cut down forests and construct new buildings. Land suitable for growing plants is diminishing. Hydroponics is the next way to grow food without the need of land and soil. Because of this, the system can be anywhere.

Advantages

There are many advantages to hydroponics, including these:

1. You can grow anywhere,
2. Uses 20 times less water than soil based gardening.
3. Your environment is sterile, which means no pesticides.
4. You will use 20% less space for growing.
5. The water used in the hydroponic system is reusable, allowing you to conserve water.
6. Harvesting is easier.
7. You can grow year round if indoors.

Disadvantages

Even though there are many advantages to a hydroponics system, there are also disadvantages.

1. Putting together a hydroponic system is not cheap.
2. Constant monitoring is required.
3. Hydroponic systems are vulnerable to power outages,
4. In the event of a power outage that outlasts your generators, you will need to manually watering your garden, taking away time.
5. Water-based microorganisms can inhabit your system quite easily.
6. Growing a hydroponic garden demands technical expertise.
7. Production is limited compared to field conditions.
8. If a disease appears, it will affect every plant in the system.
9. Without soil to serve as a buffer if the system fails, plant death will occur rapidly.

Growth Mediums (Bedding)

When growing plants in a hydroponic system, bedding is key to how the plants thrive. Bedding holds the plants up and allows the roots to grow in the water. Without the bedding, the plant could float. Some growth mediums include, but not limited to; Rockwool, grow rock, coco fiber, perlite, vermiculite, oasis cubes, floral foam, grow stone, river rock, pine shavings, and composted materials.

Nutrient Pumps

Nutrient pumps pump a chemical solution into the water that helps the plant grow. The chemicals in the solution clean out the tank, as well as give the plant nitrate. Nitrate is in soil or droppings

from animals, but since the plants are not growing in soil, they need to get nitrate from the nutrient pumps.

Types of Hydroponics Systems

1. Deepwater Culture (DWC), also known as the reservoir method, is by far the easiest method for growing plants with hydroponics. In a Deepwater Culture hydroponic system, the roots are suspended in a nutrient solution. An aquarium air pump oxygenates the nutrient solution-this keeps the roots of the plants from drowning. Remember to prevent light from penetrating your system, as this can cause algae to grow.

2. Nutrient Film Technique, or NFT, is a type of hydroponic system where a flow of nutrient solution runs over the plants roots. This type of system is on a slight tilt so that the nutrient solution will flow with the force of gravity.

3. Wicking is one of the easiest and lowest costing methods of hydroponics. When using the wicking method a material, such as cotton, that is surrounded bedding with one end of the wick material placed in the nutrient solution. The solution is then sucked up to the roots of the plant.

4. An ebb & flow hydroponics system, also known as a flood and drain system, is a great system for growing plants with hydroponics. This type of system functions by flooding the growing area with the nutrient solution at specific intervals. The nutrient solution then slowly drains back into the reservoir

5. A hydroponic drip system is rather simple. A drip system works by providing a slow feed of nutrient solution to the hydroponics medium. This waters the plants.

Materials and Methods

- Vermiculite
- Peat moss
- Grow rock
- Grow block
- Plant vessel
- Vessel grate
- 5 gallon water tank
- Water filter pump
- Hydroponics growth solution
- Recycled paper
- Recycled paper towels
- Recycled tissue boxes
- Recycled cardboard
- Pencil shavings

Procedures

Before you can complete any part of the experiment, you need to create the plant vessels and the plant vessel grate. Here are the steps to how we engineered these items.

Step 1: To create the plant vessels we first had to use Autodesk Inventor to CAD a design, we created multiple drafts, but the final is below. (*See figure 1.)*

Step 2: We then 3D printed 100 different plant vessels.

Step 3: The plant vessel grate holds each plant vessel in a hole cut through it, created by laser cutter, which was used on a piece of plexi-glass. We also had to use Autodesk Inventor to create the design for our plant vessel grate. (*See figure 2.)*

Once you have gathered all of the materials required, you must begin to set up the hydroponic tank.

Step 1: Fill up the tank with room temperature water, only fill it to five inches away from the top of the tank.

Step 2: Add the water filter pump to the bottom of the tank, we let the water filter for one day before the growth cycle began.

Step 3: Add four tablespoons of the growth solution to the water.

Now that the tank is set up, one day later you may begin to grow your plants.

Step 4: Add the plant vessel grate to the top of the tank, because the grate is the size of the tank, it should slide in perfectly. Because the tank is not filled all the way, water should not be touching the grate.

Step 5: Before adding the plant vessels into water, you must fill them with the growth media. We have a few tips for this step so your plants grow successfully.

1. When filling the vessels up with vermiculite or peat moss, be sure to pack the media into the vessels tightly. This will ensure that particles of the media don't float away in the water.
2. When packing in the grow block, it is imperitive that it is not packed down to tightly. If you pack it down too tight the plant roots will not be able to reach the water.
3. Finally, when packing the water absorbent polymer, you must let the polymer soak in a glass of water before packing them into vessels.
4. One last piece of advice is fill the plant vessels 3/4th of the way. This will allow water to reach the plant seed.

Step 6: Place each vessel into the vessel grate, and they should all be partially submerged in water.

Step 7: Plant one seed in each vessel-the media does not need to cover the seed.

Step 8: At this point the only thing you can do is wait for your plants to grow-we allowed 10 days for this process.

Step 9: Five days after planting the seeds, add four more tablespoons of growth solution.

Step 10: Once the growth cycle is finished, remove the plants from the water. Then measure the plants from before the roots start to the top of the plant. We put this information into a spreadsheet.

Step 11: If you wish to collect more data, you can repeat steps 1-10 as many times as needed.

In this next section, you can learn how to make your own recycled media.

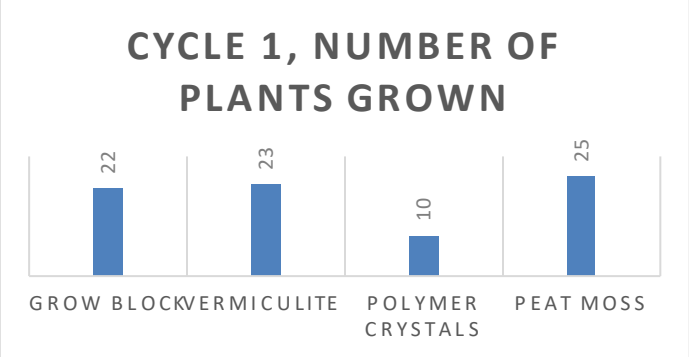
Step 1: Collect the recycled paper, paper towels, cardboard, tissue boxes, and pencil shavings. Then, shred all of these materials into thin strips.

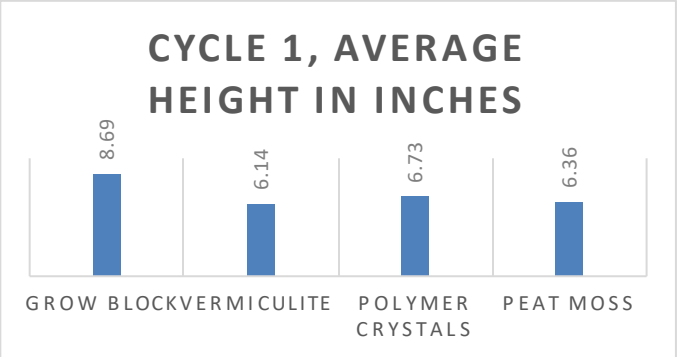
Step 2: Using 3 parts paper, 2 parts paper towels, 1 part shredded cardboard and tissue boxes, and 1 part pencil shavings. Mix these items together to create a bedding.

Step 3: Repeat the previous steps 1-10, excluding the other growth media's.

Results

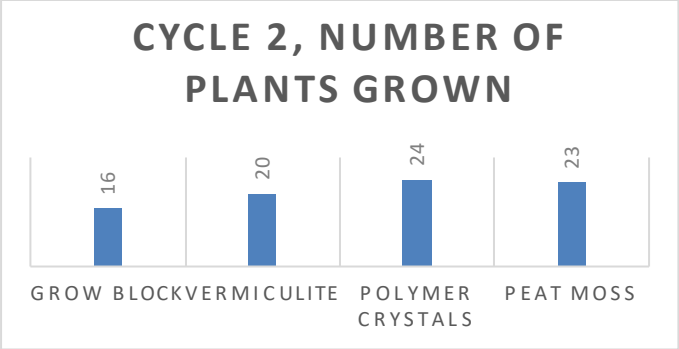
During this experiment we collected a lot of data, we collected data on how many plants grew in each type of bedding and how tall each grew. The chart below shows the number of plants that grew successfully in cycle 1, we planted 25 seeds in each different type of bedding. We noticed that 100% of plants grown in the peat moss sprouted successfully, of those plants the average height was 6.36 inches tall. Also, we noticed that plants grown in the polymer crystals where not as successful, only 40% of the plants sprouted. However, the average height was slightly taller than those plants grown in peat moss, 6.73 inches tall. Next, is a chart that shows the average height grown in inches by plants from each different type of bedding. As you can see, plants grown in grow block grew the tallest in cycle 1 with an average height of 8.69 inches

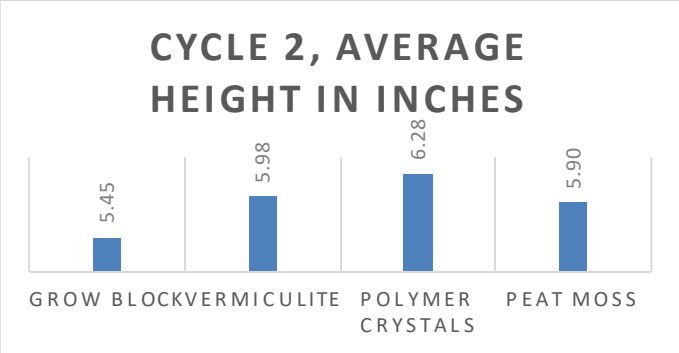




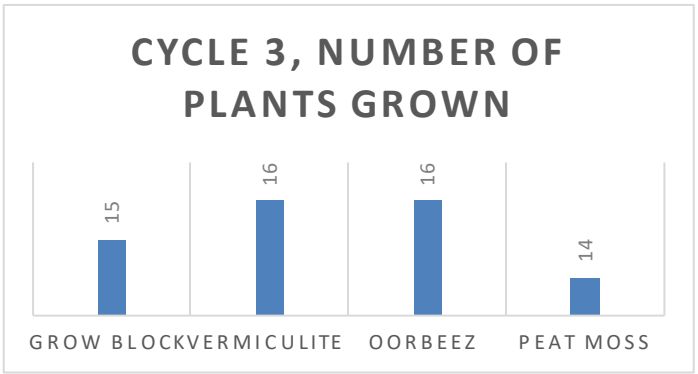
tall.

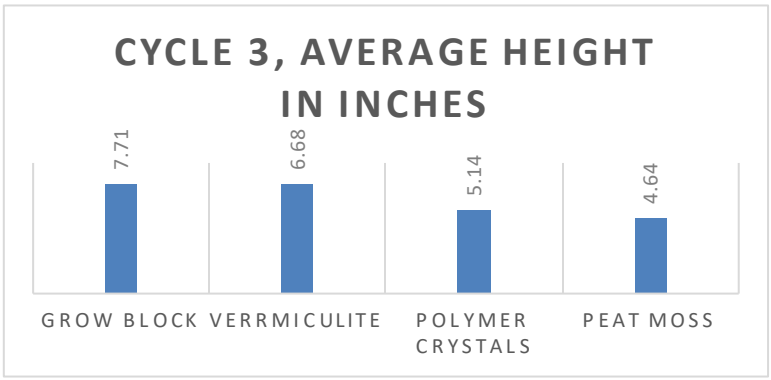
During growth cycle 2 the most plants where sprouted in polymer crystals, 96% of plants grew. The lowest amount of plants grown where planted in grow block, 64%. This stood out to us because in growth cycle 1, the least amount of plants grew in the polymer crystals. 92% of plants grown in peat moss sprouted. Another surprising piece of data is that the average height of a plant grown in the polymer crystals was 6.28 inches tall, which is the greatest average height from this cycle. The heights of plants during this growth cycle where significantly shorter compared to cycle 1. The shortest average height was 5.45 inches, this occurred in grow block.





In the last growth cycle using store-bought bedding we noticed not as many plants grew. We believe this is because we used a different type of water. The experiment began using well water but, then we moved the system to a different location that only had city water. We believe that slightly skewed the results. During this cycle, the most plants grown where planted in polymer crystals and vermiculite, with 64% of plants sprouted. As you can see in the chart below, only 56% of the peat moss plants grew, which is a significant decrease in the amount of plants grown in cycle 1. Lastly, only 60% of plants grown in grow block sprouted. In the next chart below, you can see the average height that the plants grew. The largest average height that the plants grew to was 7.71 inches tall, these plants where grown in grow block. These results are very similar to those we saw in cycle 1. Lastly, the lowest height that plants grew was 4.64 inches in peat moss.





In the last trial we used home-made bedding from recycled materials. The results from this trial show that 77% of the plants we planted grew. And the average height of those plants was 4.13 inches tall. Even though the average height of these plants are shorter than the previous results, we consider the recycled bedding a success. We do so because, the average success rate for the past three cycles in polymer crystals and grow block are less than the recycled bedding's success rate. Polymer crystals have a success rate of 66% and the grow block had a success rate of 70%. Also, it cost us $32.00 to pay for all four different types of bedding, the recycled bedding as free.

Discussion and Conclusions

While we were collecting data for our experiment we saw differences between each growth cycle. During cycle 1, we only saw 10 successful sprouts grown in polymer crystals. In growth cycle 2, 24 of the seeds we planted grew, we do not know why this change occurred. Another interesting change between growth cycle 1 and 2 is the difference between average heights of the plants. The tallest average height for growth cycle 1 was 8.69 inches tall, in cycle 2 it was 6.28 inches.

Acknowledgment

We would like to thank our parents, who helped support this project financially. Also, thank you to Mr. Bottelier, our project mentor, and Mr. Roberts, who helped us use the laser cutter.

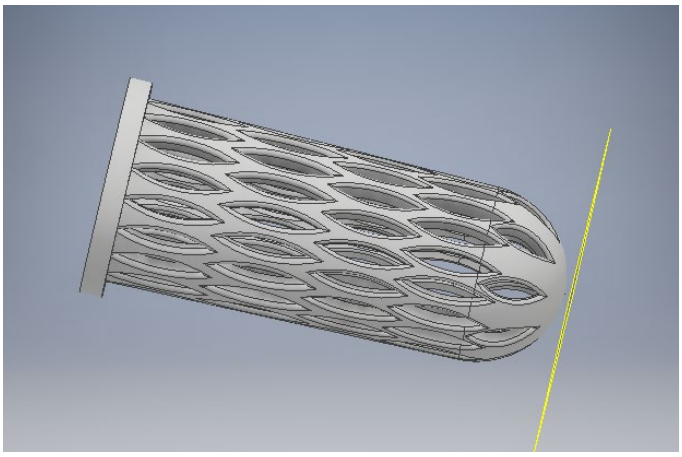


Figure 1.

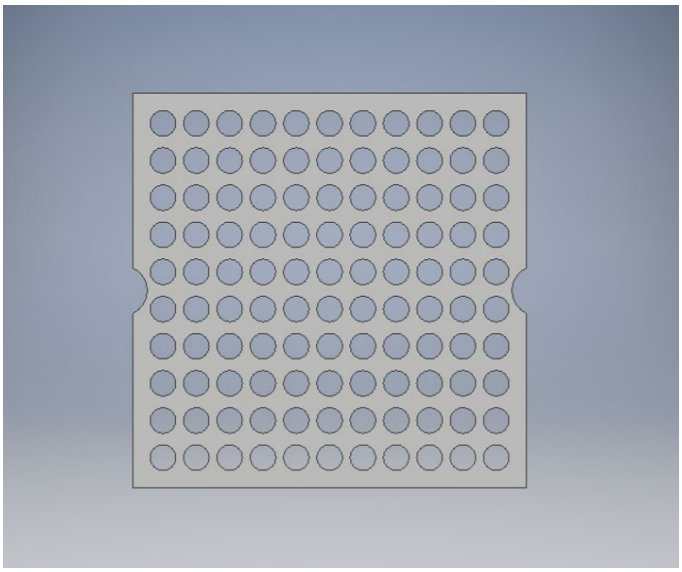


Figure 2.

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