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EVALUATING THE EFFECIENCY OF HYDROPONIC FARMING

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ABSTRACT

This experiment investigates the efficiency and therefore viability of hydroponic farming in comparison to traditional farming through building an at-home hydroponic farm. The aim of the experiment was to test if hydroponic farming could be used on an industrial scale and whether it could potentially replace soil-based farming. It measures the growth rate of plants in hydroponic and in traditional conditions by making one farm of each type. Four different plants: carrots, garlic, mint, and spring onions are grown in each farm under constant conditions- the sunlight, temperature, care given etc.- and are regularly measured and compared. The experiment finds that plants generally grow more efficiently in hydroponic conditions, however, geophytes do not grow well hydroponically compared to traditionally, likely due to overwatering. It also finds that hydroponic systems are easier to care for than traditional systems.

I. INTRODUCTION

Agriculture is, and always will be an essential asset of society. It provides us with raw ingredients used to make an infinite number of recipes. However, over the years, many problems have risen with traditional farming. The biggest issues include, the amount of water needed to grow crops, the time and effort it takes to maintain and care for the plants, the space our farms take and the fact that not all plants grow worldwide leading to mass imports. A solution to these problems could be hydroponic farming- growing plants in nutrient-rich water rather than soil. Hydroponics have many benefits including using less water and taking up less space as systems can be stacked vertically. However, would the growth speed be able to keep up with the high demand for crops worldwide? This experiment explores the possibility of using hydroponics commercially by measuring and comparing the growth rate of plants in comparison to traditional farming.

II. METHODOLOGY

To perform the experiment, a hydroponic and a traditional system were needed.

Materials for the hydroponic farm:

- 17-liter plastic box
- Air stone
- 0.8 m airline tubing
- Protective check valve
- Pro JBL aqua test (pH test)
- JBL pH minus 16.75 ml
- JBL pH plus 3 ml
- easy-life PROFITO (plant fertilizer) 2ml
- Toothpicks to hold some of the vegetables/herbs.
- Four plant pots
- 17 liters of water
- 1 carrot stem
- 1 mint plant
- 2 garlic cloves
- 3 spring onions

Materials for the traditional farm:

- Plant soil
- Plant fertilizer
- 4 plant pots

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- Water
- 1 carrot stem
- 1 mint cuttings
- 2 garlic cloves
- 3 spring onions

Steps for making the hydroponic farm:

Step 1: Assemble the aerator**.**

To assemble the aerator, I first cut about 0.8m of the air pipe. Then, I attached one end of the pipe to the air pump and the other end to the air stone. I made another cut in the middle of the pipe and attached the protective check valve to the available sides of the pipe making sure that the arrow on the valve was pointing in the direction of the air stone.

Step 2: Prepare the box.

First, I removed the lid of the 17l box and cut four squares into it using a heated knife making sure that the holes were large enough to fit the plastic pots in which I was going to place the plants such that the pots would not be completely submerged. I also made a small hole in the middle of the box just large enough for the pipe of the air stone to fit through.

Step 3: Prepare the water.

Next, I filled the farm with water and, added in 1.7ml of fertiliser. I made sure to mix well to have the fertiliser evenly distributed before measuring the pH level of the water. I added the fertiliser to the water before checking the pH to be sure that the fertiliser would be considered when adjusting the pH. To measure the pH, I took a 5ml sample of the water from the farm and added 5 drops of the aqua test into the water before allowing it to rest for 5 minutes. By comparing the colour of my solution with the provided chart, I measured that the pH was approximately 7 where the ideal pH for the type of plants I was growing was 6. To rectify this, we used 2.5ml of pH minus to lower the pH. I retested the pH and repeated this process until I achieved the correct pH of six. Achieving this took a total of 16.75ml of pH-minus, 3ml of pH-plus and 8 pH tests.

Step 4: Assemble the farm.

Once the pH and fertilisation of the water was completed, I placed the air stone inside the hydroponic farm through the previously made hole and plugged it in. I placed the plant pots into the holes and the different plants into the plant pots. I now had a functioning hydroponic farm.

Method of the experiment:

The experiment lasted 21 days.

The length of the spring onions was measured daily for a period of 7 days and then every other day for a period of 14 days. Photos were taken daily of each plant to document the growth.

The traditional farm was watered every 4 days.

Both sets of plants were kept in a brightly lit area with an average temperature of 22°C.

The pH of the water of the hydroponic plants was 6.

III. MODELING AND ANALYSIS

Model and Material which are used is presented in this section. Table and model should be in prescribed format.

Figure 1: Traditionally farmed plants

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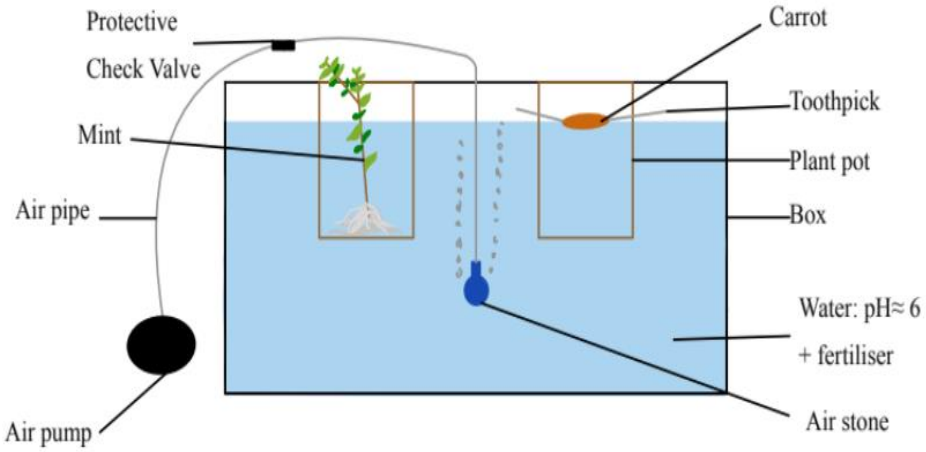


Figure 2: Scheme of at-home hydroponic farm

IV. RESULTS

Spring onion growth

The length comparison between the hydroponically grown spring onion and the traditionally grown spring onion over the course of five days:

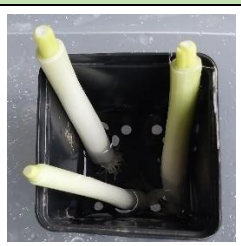
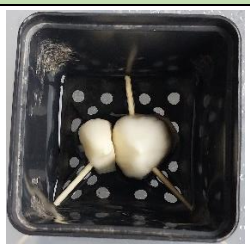
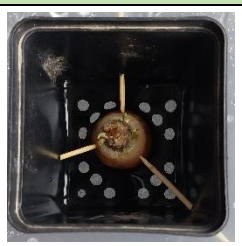
Table 1: Growth of spring onions

	HYDROPONIC PLANT		TRADITIONAL PLANT		
DAY	**TOTAL**	**CM OF GROWTH**	**TOTAL**	**CM OF GROWTH**	**COMMENTS**
1	1cm	/	1cm	/	
2	1.8cm	0.8cm	1.4cm	0.4cm	
3	2.5cm	0.7cm	1.9cm	0.5cm	Second leaf begins to grow in hydroponic
4	3.2cm	0.7cm	2.7cm	0.8cm	Second leaf has grown a lot
5	4.2cm	1cm	3.5cm	0.8cm	Second leaf begins to grow in traditional
21	26.2cm	/	23.3cm	/	Hydroponic plant is 2.9cm longer.

Pictures of growth

Hydroponic plants

Table 2: Pictures of hydroponic plant growth Traditional plants

DAY	SPRING ONION	MINT	GARLIC	CARROT
1				

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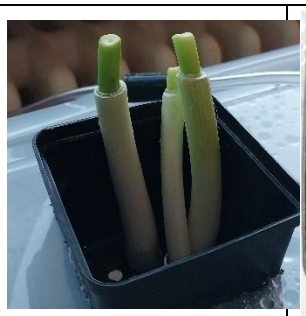
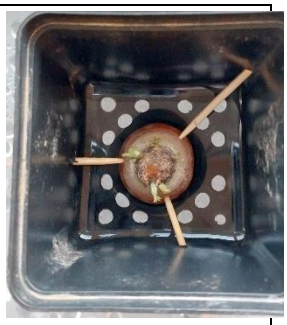
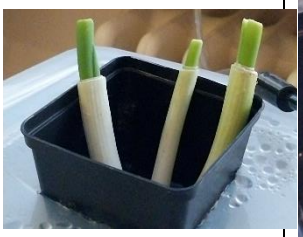
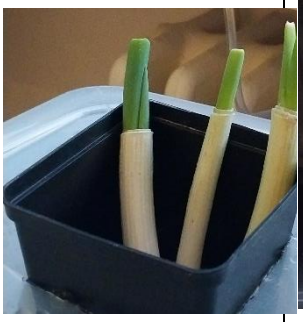
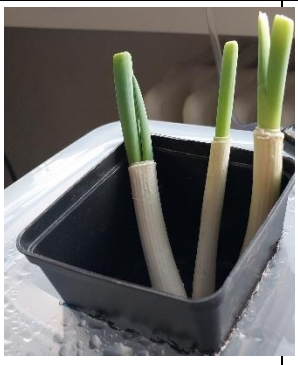
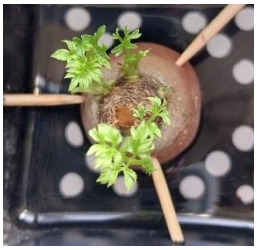
2				
3				
4				
5				
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Table 3: Traditional plant growth

DAY	SPRING ONION	MINT	GARLIC	CARROT
1				
2				
3	 		
4	 		
5	 		

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21				

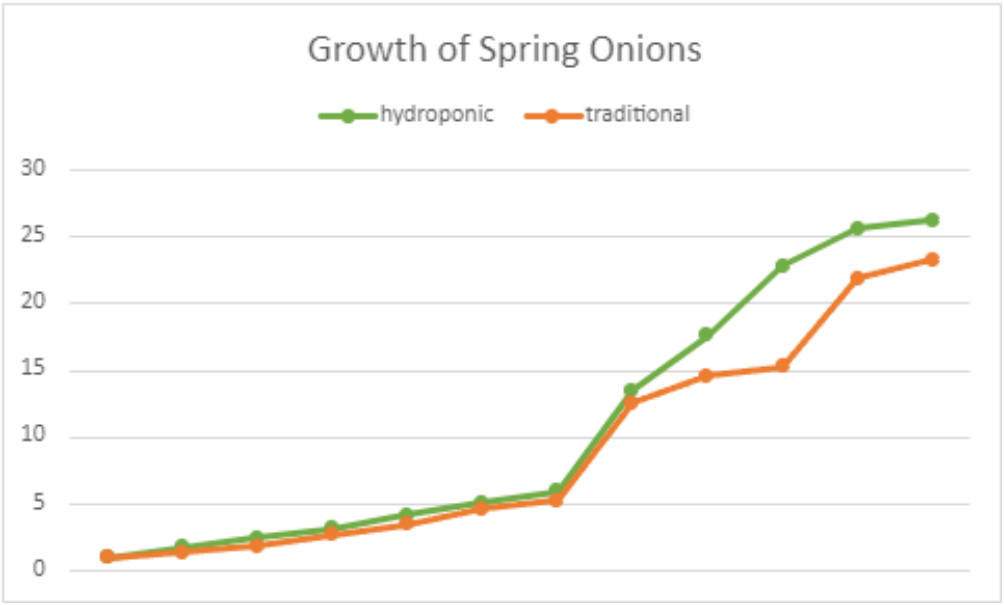

Figure 3: Spring onion growth over 21 days

V. DISCUSSION

With an overall increase of 25.2cm for the hydroponic spring onions and 22.3cm for traditionally grown spring onions, we can observe a more notable change in the lengths of the hydroponic spring onions. This can lead us to conclude that the spring onions grown in water grew more efficiently than those in the soil. Furthermore, the carrot in the hydroponic farm had significant leaf growth. However, the carrot planted in soil did not grow. This means that the carrot also grew better in the hydroponic farm. It is possible that the reason that the carrots didn't grow in the soil is that they were not given as much care as they needed, however the hydroponic plants were given the same amount of care and flourished. This can allow us to theorize that hydroponic systems are easier to maintain than traditional systems.

The garlic that grew in the soil grew far better than the hydroponic garlic. This could be because garlic typically doesn't need too much water to survive, and it was placed in water constantly. The garlic was likely overwatered, and it began to rot.

By the end of the experiment, the hydroponic mint cuttings noticeably grew far more than the traditional mint cuttings. It had many more leaves and was far longer. The mint plant also grew more efficiently hydroponically.

VI. CONCLUSION

The conclusions we can draw from this experiment are that hydroponic farming could be a viable replacement for traditional farming as hydroponics are compact, affordable and the growth of certain plants are faster in hydroponics than in traditional farming. However, geophytes grow better traditionally. A reason that the geophytes grew far better in soil could be because they usually grow underground and were therefore overwatered and overexposed to sunlight. However, carrots, which also grow underground, grew better in hydroponic farming therefore it is difficult to draw a concrete conclusion about whether a certain group of plant grows more efficiently. More research and testing would be necessary to conclude the cause of this result.

Hydroponic farming is, in some cases, more efficient than traditional farming, therefore being a viable addition rather than a replacement to traditional farming. Implementing hydroponics could be an excellent method of

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decreasing the total cost, resources, land, and labor needed to produce enough food for the population. In smaller countries, vertical hydroponics could be used to maximize the usage of the available space.

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