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The Effects of Different Growing Mediums in a Hydroponically Grown Lettuce

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ABSTRACT

Hydroponics has become a popular method of plant cultivation, offering several benefits such as increased yields and efficient water usage. The hydroponic medium used is crucial for the growth and development of plants as it provides a foundation for the roots to receive the necessary oxygen and nutrients.

With numerous growing mediums available, the choice of the hydroponic medium becomes a significant factor in the success of hydroponic setups. In this context, the researchers' study examines the efficiency of different mediums such as rock wool, hydroponic sponge, and pool noodles in hydroponic lettuce production.

The study shows that Rockwool is the most efficient medium, as it offers the highest number of leaves and heaviest fresh biomass, while still being water-efficient. Although other mediums such as coco peat, hydroponic sponge, and pool noodles show promise, Rockwool stands out as the best option.

This study is significant for hydroponic cultivators and farmers as it helps them make informed decisions about which medium to use for their hydroponic setups. With Rockwool, farmers and producers can cultivate high-quality plants firmly, leading to increased yields and profitability. Overall, this study contributes to the advancement of hydroponics as a sustainable and efficient method of plant cultivation.

KEYWORDS: *Hydroponics, growing mediums, increased yields, and profitability*

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1. THE PROBLEM AND ITS SCOPE

1.1. Background of the Study

Since the beginning of human existence, traditional farming has long perished but still exists. Even in the present, this is still important and relevant. Farming provides the majority of the food and other resources that the population uses. They utilize a lot of resources because it is one of the largest industries in the world. Furthermore, a certain study called Hydroponics offers a solution to the problem of resource use. In comparison to conventional farming for United States Agriculture, hydroponics uses fewer resources with an increase in plant harvest.

This study is thought of with the purpose of helping the plants grow faster, healthier, and bigger using water-based minerals through hydroponics. Using water-based mineral fertilizer solutions in aqueous solvents, hydroponics is a subset of hydroculture and a method of horticulture that involves growing plants, typically crops, without soil. Growing media are solids, liquids, or semi-solids employed to assist the development of a population of microorganisms, cells, or tiny plants by cell proliferation. Hydroponics uses a variety of different porous growth mediums nowadays, including rockwool cubes, Foam or Pool Noodles, and Hydroponic Sponges.

First of all, Foam or Pool Noodles are known mostly by kids when they start learning how to swim or float, for rescue reaching, in various forms of water play, and for aquatic exercise. There are other uses for Pool Noodles, and one of them is for Hydroponic farming since they can grow plants with the help of water-

based mineral fertilizer solutions. Rockwool Cubes are used by most professionals in Hydroponic farming. It has the best material and is considered the most expensive one out of all. Hydroponic Sponges are an unknown element but they can also be used in planting since it helps in growing plants.

Second, the researchers have discussed that using pool noodles or foam, rockwool cubes, and hydroponic sponges help to embrace the plant and provides a better and healthier environment, especially in preventing bacteria that want to enter the Lettuce

The development of hydroponics should benefit from this research. Therefore, by the end of the project, researchers will have developed a solution that will aid other researchers in developing strategies for enhancing the growth and productivity of hydroponically grown plants. Due to its lower resource consumption, hydroponics may hold the secret to sustainable living. As this can supply us in the long term, it will be helpful and benefit many people.

1.1.1. Statement of the Problem

Growing mediums are alternatives for growing plants as it supplies the needed water for plants to grow and in no need of soil. This study aims to capably do what soils can, mediums can grow, and nurture a plant's development similarly to soil and how it uses different resources and is environmentally friendly. It also addresses the following specific objectives and pertaining questions. How will the different Growing Mediums/Media affect lettuce's Growth?

1. Will the medium Rockwool Growing Medium affect and stunt lettuce's growth with:

a) The number of the leaves?
b) The height of the lettuce?
c) The height of the stem?
d) The length of the roots?

2. Will the medium Pool Noodles Growing Medium affect and stunt the Lettuce's growth with:

a) The number of the leaves?
b) The height of the lettuce?
c) The height of the stem?
d) The length of the roots?

3. Will the growing medium Hydroponic Sponge Growing Medium affect and stunt the Lettuce's growth with:

a) The number of the leaves?
b) The height of the lettuce?
c) The height of the stem?
d) The length of the roots?

4. What type of medium is suitable in enhancing the growth development of the lettuce plant in the:

a) Rockwool growing medium?
b) Hydroponic sponge growing medium?
c) Pool noodle growing medium?

Hypothesis: Lettuce (Lactuca Sativa) grows quite well when cultivated hydroponically with rockwool or Coco peat.

1.1.2. Significance of the Study

This study will benefit the following entities:

Consumer and Business Sector:

Medical professionals: First of all, health assessments and risks are priorities in everyday living, most especially our food intake. That is why this could be beneficial. As lettuce from hydroponic systems can be grown without soil, the risk of contamination and disease from the soil is reduced. As a result, medical professionals can treat patients with weakened immune systems or other medical conditions with the lettuce that the study will produce. The professionals can choose and evaluate a safer and more secure option as a source of medication.

Hydroponic Cultivators: They receive their advantages in terms of crop production and cultivation, this helps them in terms of production all year round not only in profit but also in quality. Hydroponic systems can produce lettuce all year round, enabling farmers to supply consumers with fresh food at all times of the year. In this, hydroponic gardening producers may help lead to a more stable and reliable source of revenue and production for food

Urban residents: These urban cultivators are striving to find ways to grow their hydroponic plants better. Using hydroponics, urban residents may be able to grow their own fresh crops in constrained areas like balconies or rooftops. This is extremely helpful for people who live in areas with limited access to nutritious foods, such as food deserts, which overall help in easy food access.

Environmentalists: Generalizing the idea of our community, this step by step process allows these experts to evaluate the best and accurate way to find viable alternatives. When compared to conventional farming methods, hydroponics can be a more environmentally friendly and sustainable way to grow lettuce. The environmental impact of agriculture is lessened by using fewer pesticides and fertilizers and less water when using hydroponics.

Parents: Specifically, working parents that have time to cook and provide home-cooked meals and any person who can at home can benefit from this hydroponic plant. Since a high-quality plant can offer families that want a variety of wholesome but delectable cuisine. The consumers using the grown lettuce and who also consume and eat it at home would surely gain a promising taste of deliciousness as hydroponically grown lettuces are freshly grown and cropped

Chefs and kitchen staff: They are always to choose a healthy and best ingredient that would give the best taste of a dish they can make. This allows them to gain advantages in using hydroponically grown lettuce as it provides one of the many ingredients of scrumptious soups, main entrees, and side dishes.

Consumers: On the other hand, consumers are one and only neither right or wrong which cannot be avoided as picky eaters. Most dont like vegetables in general. However, they would love a lettuce that is hydroponically grown because it is one of the resources that may be employed to produce nutritious items for people to eat. According to WebMD Editorial Contributors, Vitamin C, an antioxidant with a reputation for battling free radicals, is present in lettuce. It could assist in lowering the likelihood that the sun, tobacco, and pollution can harm your skin. Additionally, vitamin C contributes to the body's normal collagen production and may help prevent aging symptoms like wrinkles and fine lines.

Research Sector:

Future Researchers: Researchers such as the youth because this study and experiment would prove to be beneficial and of use to future researchers as it would give inspiration and basis or logistics for their future research and studies, It would also help give evidence to some other researchers and would prove a theory about the effects of different growing mediums to a hydroponically grown lettuce.

1.1.3. Scope and Limitations

Scope

The research was carried out at 43-H Greyhound Subdivision in Kinasang-an Pardo, Cebu City. The researchers employed four different growing materials to establish four different hydroponic setups with lettuce

(Lactuca Sativa). The setups are set up in a tiny greenhouse outside one of the researchers' homes. To ensure that the experiment continues, there are 6 samples per setup. The purpose of this research is to establish which medium is best among rockwool, Coco peat, hydroponic sponge, and pool noodles.

Limitations

The study on the effects of the different growing mediums also faces its own issues and limitations using the Kratky method in 4 different growing mediums. First of all, the study only evaluated 3 alternative growing mediums; rockwool, hydroponic sponge and pool noodles. One of the mediums, Coco peat, is considered as the control group because it is widely used by most cultivators of a hydroponic setup.

1.1.4. Definition of Terms

Hydroponics: Is the cultivation of plants without soil, instead through the means of a nutrient-rich water solution that delivers the necessary nutrients directly to the plant roots.

Dependent Variable: Is the variable that is being tested in an experiment.

Independent Variable: Is the variable that stands alone and isn't changed by other variables.

Constant Variable- Is the variable whose values remains unchanged and the same.

Half Strength: ½ or half strength solution also effectively doubles the water gradient between roots and solution, so might increase the diffusion of some nutrients out of the very young roots.

Full Strength: whole or full strength solution provides the total amount of nutrient solution which completes the process of adding nutrient solutions to the water, and helps in increasing the growth of the plant.

Micro Nutrients: Micronutrients are needed in tiny amounts but are essential. These include zinc, nickel, boron, copper, iron, manganese, molybdenum, boron, and chlorine.

PPM: Refers to parts per million which is a set of units to describe small values of miscellaneous dimensionless quantities.

PH Level: Also refers to "potential of hydrogen". pH level is the scale used to specify the acidity or basicity of an aqueous solution.

1.2. REVIEW OF RELATED LITERATURE AND STUDIES

This study is anchored on the theory of Adriano Bulla which states that you can greatly enhance the performance of your Kratky garden by using a growing medium. It determines the effects of the different growing mediums in the growth of a Hydroponically grown lettuce using the Kratky method. Kratky hydroponics is considered a passive method because it does not rely on pumps to circulate water and nutrients; instead, it relies on a stagnant

hydroponic solution and air space. In addition, the information about the studies relevant to the proposed research is presented below:

1. Hydroponic Cultivation of Lettuce Using Different Substrates and Irrigation Intervals
2. Evaluation of Different Growing Substrates on Lettuce (Lactuca sativa) under Non – Circulating Hydroponic System
3. Effect of Agricultural Medium in Hydroponic System on Growth and yield of Two Hybrids of Lettuce
4. Performance of Lettuce (Lactuca sativa L.) Under Soilless Cultivation System Using Different Growing Media and Irrigation Regimes
5. Hydroponic cultivation of lettuce (Lactuca sativa L.) using a foam noodle medium
6. Hydroponic Lettuce Production in a New Substrate of Coconut Coir and Perlite in Foam Noodles
7. The Effect of Different Irrigation Frequencies on Lettuce Growth in Hydroponic Sponge Systems
8. Effects of Hydroponic Sponge Media on Growth and Quality of Lettuce"
9. Effect of Pool Noodle Diameter on Lettuce Growth in a Hydroponic System
10. Effects of hydroponic medium and nutrient solution on growth, yield, and quality of lettuce

1.2.1. This study is anchored on the theory of Hydroponics Cultivation of Lettuce Using Different Substrates and Irrigation Intervals by Tüzel et al. (2018).

Conducted to investigate the effects of different substrates (rockwool, perlite, coconut coir, hydroponic sponge, foam noodle, and a mixture of perlite and coconut coir) and irrigation intervals (4, 6, and 8 hours) on the growth and yield of lettuce (Lactuca sativa L.) under hydroponic cultivation. The experiment was conducted in a greenhouse using a randomized complete block design with three replications. The results showed that lettuce grown in hydroponic sponge and foam noodle had the highest yield and water use efficiency, while those grown in rockwool had the highest marketable yield. The mixture of perlite and coconut coir also performed well in terms of yield and water use efficiency. Irrigation intervals had a significant effect on lettuce growth and yield, with longer intervals resulting in higher yield but lower water use efficiency. Overall, rockwool for hydroponic lettuce production, and optimization is viable for balance yield and water use efficiency."

1.2.2. Evaluation of Different Growing Substrates on Lettuce (Lactuca sativa) under Non – Circulating Hydroponic System

Regarding the concept of hydroponic mediums, Hydroponic mediums are materials used in hydroponic systems to support the growth of plants. A study conducted by Razvy, M. A. (2022). The study was conducted to evaluate the performance of different growing substrates on lettuce under a non-circulating hydroponics system. The Completely Randomized Design (CRD) with four replications was used to test the following treatments: T1 – Rockwool, T2– Coco peat, T3 – Carbonized Rice Hull (CRH) and T4 – Sawdust. Results show that plants under coco coir (T2)–obtained the tallest and longest roots while the most number of leaves and heaviest fresh biomass was registered in rock wool (T1). In the absence of rock wool, the coco coir/coco peat can be used as an alternative as growing substrates for a non-circulating hydroponics system since they did not differ significantly. Overall This study excels in the process of different objectives such as tallest and longest roots , number of leaves and heaviest fresh biomass and PH water level which in our study rockwool medium giving and while having the most number of leaves and heaviest fresh biomass.

1.2.3. Effect of Agricultural Medium in Hydroponic System on Growth and yield of Two Hybrids of Lettuce

According to the study of Hydroponic Growth Media (Substrate) by S. T. Patil, U. S. Kadam, M. S. Mane, D. M. Mahale and J. S. Dhekalehigh available water was recorded in media containing a high proportion of coco peat. A study conducted by Sadhana C., Sushmita D., Subhawana S., Kushal G. (2022). The purpose of this study was to determine the effect of growing media on the growth and yield of leafy vegetables. The first factor was growing media; namely coco peat, sponge, and perlite. The second factor was crop types namely lettuce and pakchoi that were harvested in 30 days. The highest plant yield (12.55 g) was obtained from plants grown in coco peat. The broadest plant leaf width (5.54 cm) was observed in plants grown in the coco peat when compared to the sponge (4.93 cm) and perlite (4.32 cm) growing media. Overall The results of this study showed that growing media coco peat followed by sponge performed better as compared to perlite. In relation to our study For the hydroponics cultivation of lettuce and pakchoi, coco peat should be used as a growing medium for better growth and yield.

1.2.4. "Performance of Lettuce (Lactuca sativa L.) Under Soilless Cultivation System Using Different Growing Media and Irrigation Regimes".

According to Dr. Gioia Massa focuses on optimizing plant growth and productivity in closed or controlled environments. A study conducted by Basra S, Tariq M , and Munir A stated that they conducted a pot experiment to evaluate the performance of lettuce under a soilless cultivation system using different growing media and irrigation regimes. Four growing media (rockwool, perlite, vermiculite and coco peat) and three irrigation regimes (daily, alternate day and once in three days) were used in this study. The results showed that the lettuce grown in rockwool had significantly higher shoot length, fresh weight and dry weight as compared to other growing media. The interaction of growing media and irrigation regimes in relation to our study. Rockwool is a suitable growing medium for lettuce production and daily irrigation is recommended for optimal yield.

1.2.5. "Hydroponic cultivation of lettuce (Lactuca sativa L.) using a foam noodle medium"

This study is anchored by "Hydroponic Cultivation of Lettuce Using Different Substrates and Irrigation Intervals" by Rodriguez-Felix, V., Gutierrez-Miceli, C. M., Hernandez- Aguilar, E., Rodriguez-Herrera, L. A., & Damian-Hernandez, M. A. (2020). They conducted this study, to evaluate the growth and yield of lettuce (Lactuca sativa L.) grown in a new substrate mixture of coconut coir and perlite in foam noodles. The lettuce was grown for 35 days and was irrigated with a nutrient solution. The results showed that lettuce grown in the foam noodle system had higher fresh and dry weights, as well as larger leaf area, compared to lettuce grown in a traditional soil-based system. Proportionate to our study, the foam noodle system combined with the coconut coir and perlite substrate can be a suitable option for lettuce production in a hydroponic system.

1.2.6. "Hydroponic Lettuce Production in a New Substrate of Coconut Coir and Perlit in Pool Noodles"

According to the study of "Mediums in hydroponic systems" due to their porous structure that provides support to the plant roots and retains moisture and nutrients for optimal growth. Three different irrigation frequencies were tested: twice a day, once a day, and once every two days by M. Yamanashi, S. Yamamoto, M. Adachi, and Y. Nakano (2019) The plants were evaluated for growth parameters, including fresh weight, dry weight, plant height, stem diameter, and leaf area. The plants grown in the hydroponic sponge system had a higher fresh weight and dry weight compared to the plants grown in traditional hydroponic systems. In relation to our study hydroponic sponge systems have different effects on the specific type of hydroponic system.

1.2.7. "The Effect of Different Irrigation Frequencies on Lettuce Growth in Hydroponic Sponge Systems'

According to Dr. Md. Mahfuzur Rahman, sponges made of materials such as foam or rock wool are commonly used as the growing medium for plants, providing support and retaining moisture and nutrients for optimal growth. Three different irrigation frequencies were tested: twice a day, once a day, and once every two days by M. Yamanashi, S. Yamamoto, M. Adachi, and Y. Nakano (2019) The plants were evaluated for growth parameters, including fresh weight, dry weight, plant height, stem diameter, and leaf area. Results showed that lettuce grown in the hydroponic sponge system had similar or better growth parameters compared to plants grown in traditional hydroponic systems. Such as the relation in between our study the hydroponic sponge had similar and or different growth parameters in cases of different mediums.

1.2.8. "Effects of Hydroponic Sponge Media on Growth and Quality of Lettuce"

According to Yan W, Wang X, and Guoqing Li (2019) Effects of Hydroponic Sponge Media on Growth and Quality of Lettuce. This study found out that the use of hydroponic sponge media as a substrate for lettuce production resulted in significantly higher shoot and root dry weight, leaf area, and chlorophyll content compared to lettuce grown in rockwool and vermiculite media. The hydroponic sponge media had better water retention and aeration properties compared to rockwool and vermiculite media, which could explain the better growth and nutrient uptake observed in the lettuce plants. In relation to our study this suggests that hydroponic sponge media could be a promising substrate for lettuce production in hydroponic systems due to its superior water retention and aeration properties, resulting in improved plant growth and product quality.

1.2.9. "Effect of Pool Noodle Diameter on Lettuce Growth in a Hydroponic System"

According to M.M. Hughes, M.W. Van Iersel, P.A. Thomas conducted a study on the Effects of Pool Noodle Diameter on Lettuce Growth in a Hydroponic System in 2018. This study examined the effect of pool noodle diameter on lettuce growth in a hydroponic system. The researchers tested three different pool noodle diameters (2.5 cm, 5 cm, and

7.5 cm) and compared the growth and yield of lettuce plants grown in different noodle sizes. The study found that there was no significant difference in lettuce growth or yield between the three noodle sizes. However, the researchers noted that the smaller noodle size (2.5 cm) may be more suitable for growers with limited space, while the larger noodle size (7.5 cm) may be more appropriate for larger-scale hydroponic operations. Overall, the study concluded that pool noodles could be a viable and flexible substrate option for hydroponic lettuce growers when using the option of growing lettuce in hydroponics

1.2.10. Effects of hydroponic medium and nutrient solution on growth, yield, and quality of lettuce

According to William Frederick Gericke (2019), a method of growing plants without soil, using nutrient-rich water solutions to deliver the necessary nutrients directly to the plant roots. By Jiang, W., Fu, Y., Hu, X., & Chen, J. (2018). They investigated the effects of different hydroponic media and nutrient solutions on the growth, yield, and quality of lettuce. Three types of media (rockwool, vermiculite, and perlite). Results showed that the hydroponic medium and nutrient solution significantly affected the growth and yield of lettuce. Lettuce grown in rockwool had the highest growth rate, yield, and quality, while lettuce grown in perlite had the lowest growth rate and yield. Overall, our study suggests that Rockwool is the most suitable hydroponic medium for effective lettuce cultivation.

1.3. RISK ASSESSMENT

The following table shows the hazards and associated harm that can be observed in our study and the level of the risks from low to high that go along with it. Hazards can be in the form of solid, liquid or gas if it can harm the researchers' while conducting the study. Thus, the researchers' look out for themselves for future researchers to be aware of the dangers that go along with the study.

Hazard and associated harm	Risk	Precautions
Scissors are sharp and can cause cuts/injuries	Low	Use the scissors with utmost precaution and properly set it aside after use. Avoid using rusty and dull scissors.
Water may trigger allergies on researchers and can cause symptoms	Low	Use gloves or any material to cover hands when dealing with the water solution.
The support structure of a hydroponic system is not properly maintained	Low	Frequently check the hydroponic system for indications of damage, such as wear and tear, rust, or any other harm that could weaken its structural strength.
Viruses, pathogens, and germs may infect the plant and can cause illnesses	Medium	Avoid using contaminated water. Daily check the water and its pH level for possible risk of contamination and rinse and change water if ever found contaminated. Get rid of algae or any organisms that could cause illnesses.
Nutrient solutions to feed plants, which can include various chemicals and fertilizers.	Medium	Read and follow the manufacturer's instructions and safety warnings for all chemicals and fertilizers used in the hydroponic system. Be aware of the potential hazards associated with each product.
Water could get contaminated and can cause infection	Medium	Use clean and uncontaminated water. Properly check and mix the water solutions and daily clean the water and check for any algae or contaminating agents.
Knife can cause a serious injury within the skin	High	Be careful in handling the knife and make sure that each cut is precise. Hold the knife firmly and be cautious always.

2. RESEARCH METHODOLOGY

This chapter presents the study's research methodology, including the research design, materials to be used and data gathering procedure of the study.

In this experiment, there will be a control group and an experiment group. The control group will consist of a normal Kratky method setup without any medium to support the plant's growth while the experiment group will consist of different kinds of Growing Mediums; particularly, foam noodles, Rockwool, and hydroponic sponge. Then, make sure that both groups have the same controlled variables: temperature of the environment, Amount of Sunlight, Type of Plant, and Method of Hydroponics Setup (Kratky Method). Both groups will be monitored from time to time, every other day from Monday: Wednesday: Friday, so that the progress will be recorded.

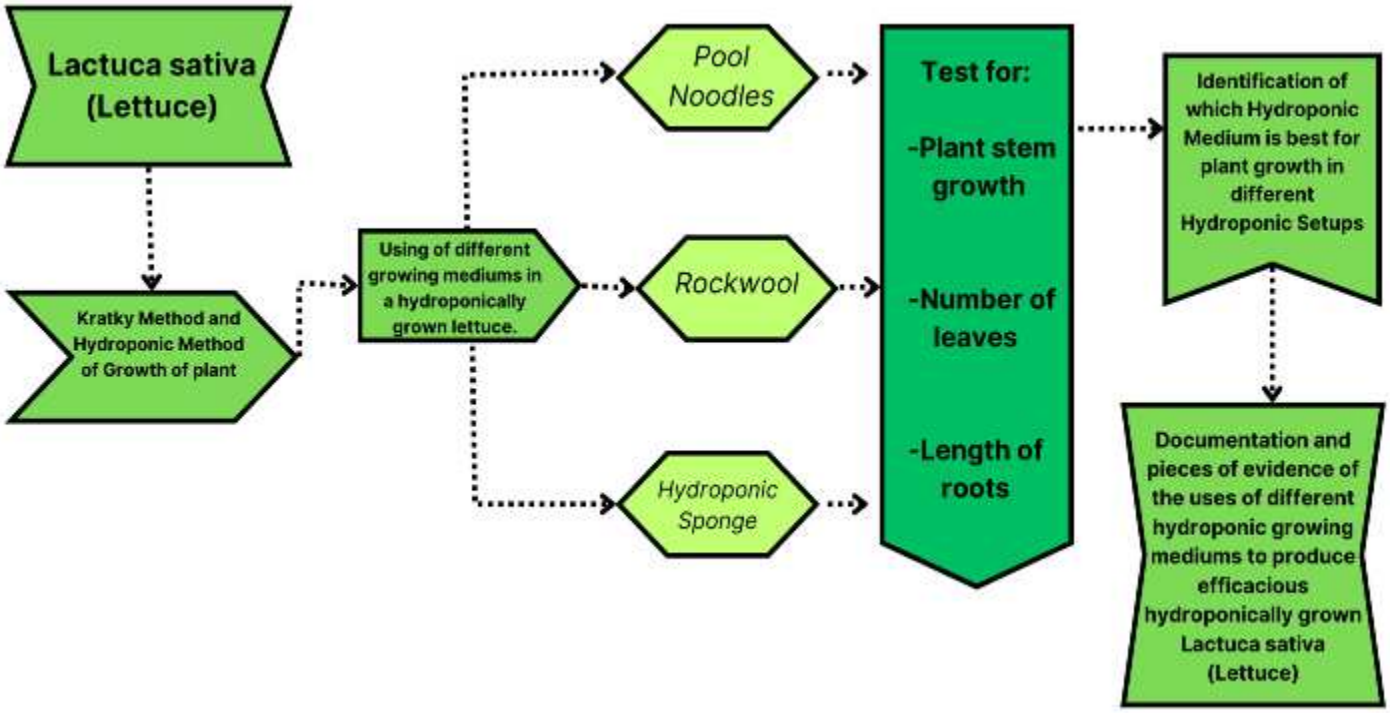


Figure 1 flow of the study

2.1. Materials Used

1. The following materials are needed to conduct the experiment:
2. 25 Hydroponic Seedling Sowing Sponge
3. 1 long piece of a Pool Noodle or 25 pieces of cut pool noodles
4. 25 pieces rockwool cubes
5. 25 Lettuce seeds
6. 1.5 Liter/s Net cups
7. Cutter/Scissors
8. Knife
9. Measuring tape
10. Nutrient Solution: Nutrihydro Solutions A and B
11. Tuna box

Steps of the Measurements in each of the Medium Used

Foam noodles- (1) Most preferably, 1 ½ inch pieces of foam to generate around 20-30 pieces; (2) the tray should be filled with around 4 cm depth of water; (3) growth of the seedling must be measured day-to-day with a tape measure; and (4) let it be exposed to 2-4 hours of sunlight every day.

Planting sponge/Hydroponic sponge – (1) In a hydroponic sponge, there are 6 blocks in each column. 7 columns should be taken, and it equals to 42 blocks wherein 42 lettuce seedlings can be placed; (2) the tray should be filled with around 2 cm depth of water; (3) after absorbing water, 1 cm more depth of water was added; (4) growth of the seedling must be measured day-to-day with a tape measure; and (5) let it be exposed to 2-4 hours of sunlight every day.

Rockwool- (1) Soaked for 15-30 seconds; (2) the water is pH level 5.2-5.5 and the normal pH level should be 5.5-6.5; (3) the blocks were measured 6” x 6”; (4) growth of the seedling was measured day-to-day with a tape measure; and (5) let it be exposed with 2-4 hours of sunlight every day.

2.2. STEPS

Preparation of Kratky Method using Tuna Box

In first to seventh day, the setups were sprayed with water every day; (2) in the eighth day, 22 ml (half strength) of nutrient solution (nutrisol A and B) and micronutrients was added; (3) in the fifteenth day, additional 22 ml (half strength) of nutrient solution (nutrisol A and B) was added; (4) in the sixteenth day, 44 ml (full strength) of nutrient solution (nutrisol A and B) was added; (5) in the seventeenth day, ppm and pH level were checked;

normal pH level is 5.5-6.5 and normal ppm is 750-800; (6) until 40 was reached, ppm and pH level were checked twice a week; and (7) in the 41st day, the water was replaced without nutrient solution so that it would be cleansed or washed.

Control Group

Coco peat- (1) For 15 minutes, 1 kilo of coco peat was boiled; (2) coco peat was added enough to fill a Styrofoam container; and (3) the setup was placed in the tuna box.

Experimental Group

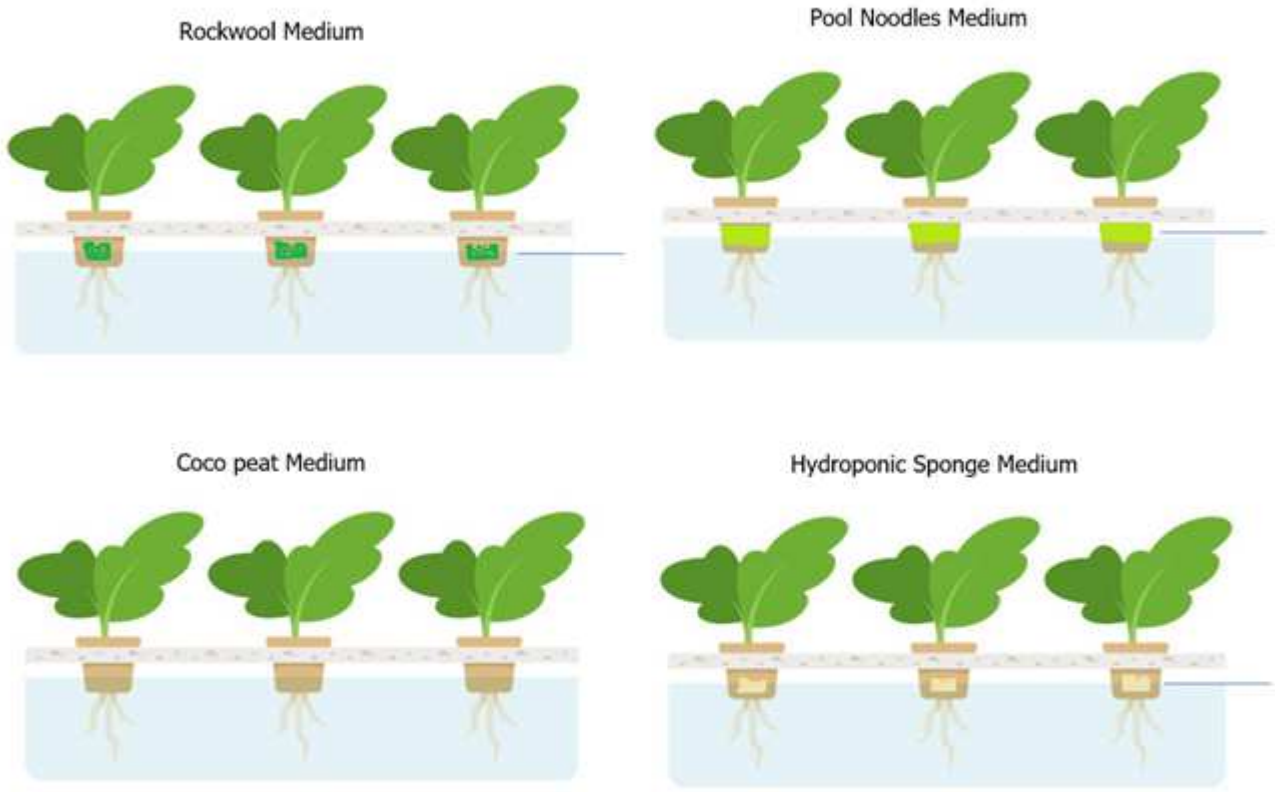
Foam noodles- (1) The foams were cut to the desired size that was suitable for the container; (2) the growing mediums were soaked with enough water in a tray, and the water pressure was carefully controlled to prevent the material from falling off; (3) water was drained from the growing medium; (4) for the growing medium, the lettuce seedling was transported; and (5) the setup was placed in the tuna box.

Hydroponic sponge- (1) Water was used to fill the planting sponge blocks; (2) sponge is soaked with water that is enough to cover its entire body; (3) water is drained from the sponge; (4) a little more water was added and rested for a couple of days; and (5) the setup was placed in the tuna box.

Rockwool- (1) Rockwool cubes were soaked in water; (2) the Rockwool cubes were poked with a stick to open a hole for the lettuce seedling; (3) the Rockwool were placed in a Styrofoam container; and (4) the setup was placed in the tuna box.

Laying Out:

Diagram 1: Hydroponic Setups



Gathering of Data- Three of the setups in the Tuna box were each setup were observed and measured for a span of 7 weeks. The plants were observed by writing the plant's growth in terms of the number of leaves, height of plant and the length of the sprouts' roots.

2.3. Documentation

Preparation Stage

Preparation Stage

In the preparation stage, the researchers prepared for the materials needed such as cutting the pool noodles with 1-inch width as seen in the picture, checking the pH level of the water, and germination of the Lactuca Sativa seeds. Before January 16, the moment that these materials were prepared, the materials were still being shipped

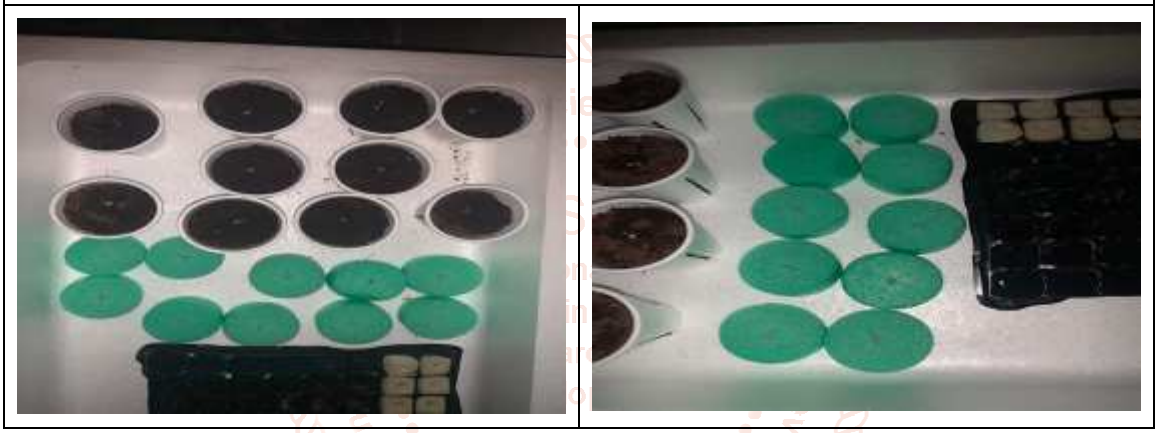
Transplanting Stage

In the transplanting stage, the mediums were transferred to the Tuna box to resume the Kratky method. Water was filled in the Tuna box and each of the setups were ready to fill 15 slots in the box.

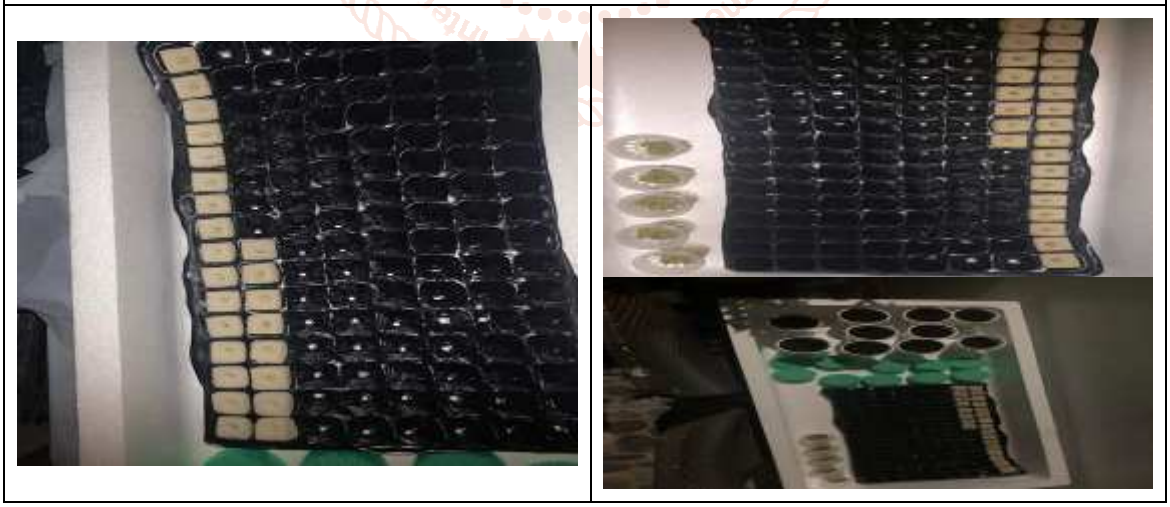
Coco Peat Setup

Rockwool Setup

Pool Noodles Setup



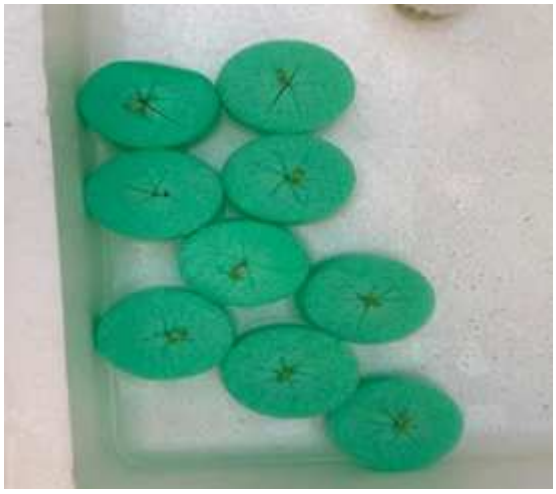
Hydroponic Sponge Setup



Experimentation Stage

Coco Peat Setup	
Before	**After**
	

Rockwool Setup	
Before	**After**
	

Pool Noodle Setup	
Before	**After**
	

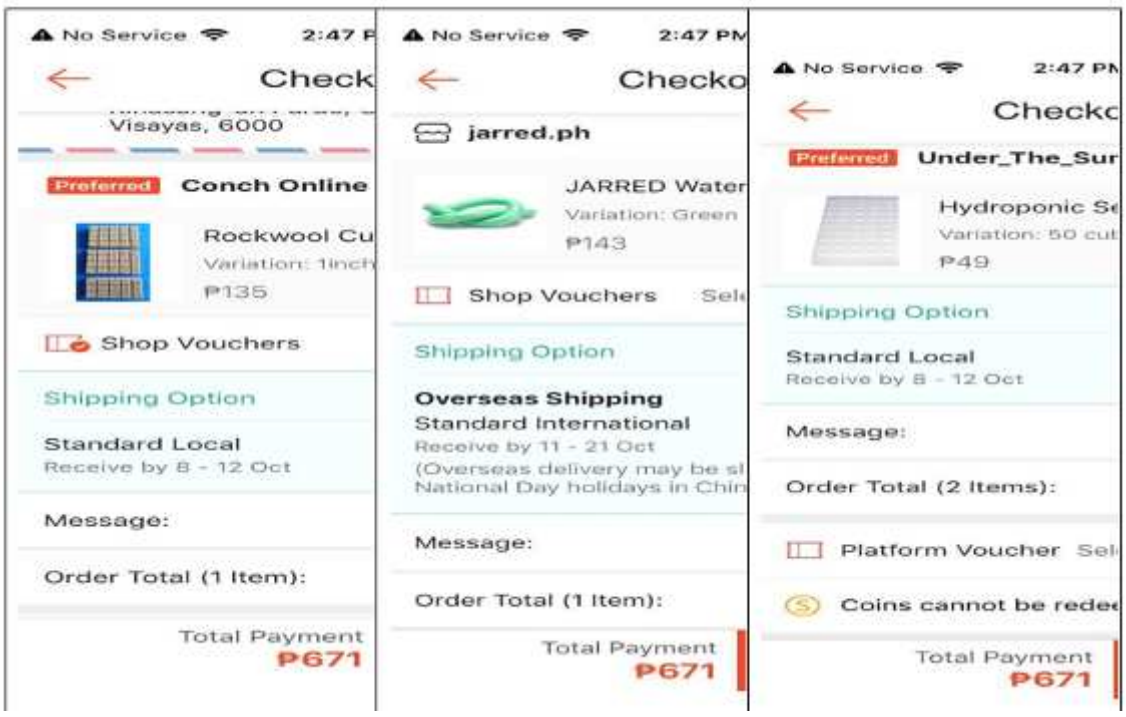
Hydroponic Sponge Setup

Before

After

Total Price Spent: 671 Pesos

Total Prices Spent



3. PRESENTATION, ANALYSIS, AND INTERPRETATION OF DATA

This chapter presents the results, analysis, and interpretation of data on which is the best suitable growing mediums used for a hydroponically grown lettuce.

Rockwool Growing Medium used in a Hydroponically Grown Lettuce

Table 1 reveals the data of how the Rockwool growing medium would affect the growth and development of a hydroponically grown lettuce.

Table 1 Rockwool Growing Medium used in a Hydroponically Grown Lettuce

DAY	DATE	Height (cm) WHOLE	No. of Leaves	Height (cm) STEM	Height (cm) ROOTS
1	Jan-16	1	2	0.5	0.2
2	17	1	2	0.5	0.2
3	18	1.2	2	0.9	0.3
4	19	1.2	2	0.9	0.5
5	20	1.5	2	0.9	0.6
6	21	1.7	2	0.9	0.9
7	22	1.9	2	0.9	1.1
8	23	2.0	3	1.2	1.2
9	24	2.2	3	1.2	1.3
10	25	2.4	3	1.2	1.5
11	26	3.0	3	1.2	1.7
12	27	3.1	3	1.2	1.8
13	28	3.6	4	1.2	2.0
14	29	4.1	4	1.6	2.1

15	30	4.6	4	2.0	2.3
16	31	5.2	4	2.3	2.5
17	Feb-1	5.7	4	2.6	2.6
18	2	6.2	4	3.0	2.8
19	3	6.7	5	3.4	3.0
20	4	7.2	5	3.7	3.2
21	5	7.7	5	4.1	3.3
22	6	8.2	5	4.5	3.5
23	7	8.7	5	4.9	3.6
24	8	9.2	5	5.3	3.9
25	9	9.7	5	5.7	4.1
26	10	10.2	5	6.1	4.2
27	11	10.7	5	6.4	4.2
28	12	11.2	5	6.8	4.3
29	13	11.7	6	7.1	4.35
30	14	12.2	6	7.5	4.4
31	15	12.5	6	7.9	4.6
32	16	12.8	6	8.2	4.8
33	17	13.1	6	8.6	5.0
34	18	13.4	6	9.1	5.2
35	19	13.7	6	9.5	5.3
36	20	14.0	7	9.9	5.5
37	21	14.3	7	10.4	5.8
38	22	14.6	7	10.8	6.0
39	23	14.9	7	11.4	6.2
40	24	15.24	8	11.7	6.35
41	25	15.24	8	12	6.35
42	26	15.24	8	12	6.35
43	27	15.24	8	12	6.35
44	28	15.24	8	12	6.35
45	Mar-1	15.24	8	12	6.35

Table 1: In the first table, the researchers' have observed that in the first week, the growth of the plants were significantly slow. The reason for this is due to the water that the setups used. It had just passed from the germination stage and continued to go on with sprayed water. In the second week, steady and continuous growth of over 3-5 centimeters. Constant growth is observed within the next 4 weeks. Thus, Rockwool is considered a high standard alternative growing medium.

Hydroponic Sponge Growing Medium used in a Hydroponically Grown Lettuce

Table 2 presents the data on how the Hydroponic Sponge growing medium would affect the growth and development of a hydroponically grown lettuce.

Table 2 Hydroponic Sponge Growing Medium used in a Hydroponically Grown Lettuce

DAY	DATE	Height (cm) WHOLE	No. of Leaves	Height (cm) STEM	Height (cm) ROOTS
1	Jan-16	1.1	2	0.5	0.2
2	17	1.1	2	0.5	0.2
3	18	1.3	2	0.9	0.3
4	19	1.3	2	0.9	0.5
5	20	1.5	2	0.9	0.6
6	21	1.6	2	0.9	0.9
7	deceased	deceased	deceased	deceased	deceased
8	deceased	deceased	deceased	deceased	deceased
9	deceased	deceased	deceased	deceased	deceased
10	deceased	deceased	deceased	deceased	deceased
11	deceased	deceased	deceased	deceased	deceased
12	deceased	deceased	deceased	deceased	deceased
13	deceased	deceased	deceased	deceased	deceased
14	deceased	deceased	deceased	deceased	deceased
15	deceased	deceased	deceased	deceased	deceased
16	deceased	deceased	deceased	deceased	deceased
17	deceased	deceased	deceased	deceased	deceased
18	deceased	deceased	deceased	deceased	deceased
19	deceased	deceased	deceased	deceased	deceased
20	deceased	deceased	deceased	deceased	deceased
21	deceased	deceased	deceased	deceased	deceased
22	deceased	deceased	deceased	deceased	deceased
23	deceased	deceased	deceased	deceased	deceased
24	deceased	deceased	deceased	deceased	deceased
25	deceased	deceased	deceased	deceased	deceased
26	deceased	deceased	deceased	deceased	deceased
27	deceased	deceased	deceased	deceased	deceased
28	deceased	deceased	deceased	deceased	deceased
29	deceased	deceased	deceased	deceased	deceased
30	deceased	deceased	deceased	deceased	deceased
31	deceased	deceased	deceased	deceased	deceased
32	deceased	deceased	deceased	deceased	deceased
33	deceased	deceased	deceased	deceased	deceased
34	deceased	deceased	deceased	deceased	deceased
35	deceased	deceased	deceased	deceased	deceased
37	deceased	deceased	deceased	deceased	deceased
38	deceased	deceased	deceased	deceased	deceased
39	deceased	deceased	deceased	deceased	deceased
40	deceased	deceased	deceased	deceased	deceased
41	deceased	deceased	deceased	deceased	deceased
42	deceased	deceased	deceased	deceased	deceased
43	deceased	deceased	deceased	deceased	deceased
44	deceased	deceased	deceased	deceased	deceased
45	deceased	deceased	deceased	deceased	deceased

Table 2: The Kratky method relies on a large body of water, which slowly gets consumed by the plants over time which can be a disadvantage for plants that require a larger root system to support their growth. If the sponge cannot hold enough water, the plants may dry out or become water stressed this is what happened, which caused the plant to wither and finally died on the 6th day. Overall This Table highlights the disadvantage of hydroponic sponge precisely USING Kratky method.

Pool Noodle Growing Medium used in a Hydroponically Grown Lettuce

Table 3 shows the data on how the Pool Noodle growing medium would affect the growth and development of a hydroponically grown lettuce.

Table 3 Pool Noodle Growing Medium used in a Hydroponically Grown Lettuce

DAY	DATE	Height (cm) WHOLE	No. of Leaves	Height (cm) STEM	Height (cm) ROOTS
1	Jan-16	1	2	0.5	0.2
2	17	1	2	0.5	0.2
3	18	1.1	2	0.7	0.3
4	19	1.1	2	0.7	0.5
5	20	1.3	2	0.7	0.6
6	21	1.3	2	0.9	0.9
7	22	1.5	2	1.2	1.1
8	23	1.5	3	1.2	1.2
9	24	2.0	3	1.5	1.3
10	deceased	deceased	deceased	deceased	deceased
11	deceased	deceased	deceased	deceased	deceased
12	deceased	deceased	deceased	deceased	deceased
13	deceased	deceased	deceased	deceased	deceased
14	deceased	deceased	deceased	deceased	deceased
15	deceased	deceased	deceased	deceased	deceased
16	deceased	deceased	deceased	deceased	deceased
17	deceased	deceased	deceased	deceased	deceased
18	deceased	deceased	deceased	deceased	deceased
19	deceased	deceased	deceased	deceased	deceased
20	deceased	deceased	deceased	deceased	deceased
21	deceased	deceased	deceased	deceased	deceased
22	deceased	deceased	deceased	deceased	deceased
23	deceased	deceased	deceased	deceased	deceased
24	deceased	deceased	deceased	deceased	deceased
25	deceased	deceased	deceased	deceased	deceased
26	deceased	deceased	deceased	deceased	deceased
27	deceased	deceased	deceased	deceased	deceased
28	deceased	deceased	deceased	deceased	deceased
29	deceased	deceased	deceased	deceased	deceased
30	deceased	deceased	deceased	deceased	deceased
31	deceased	deceased	deceased	deceased	deceased
32	deceased	deceased	deceased	deceased	deceased
33	deceased	deceased	deceased	deceased	deceased
34	deceased	deceased	deceased	deceased	deceased
35	deceased	deceased	deceased	deceased	deceased
36	deceased	deceased	deceased	deceased	deceased
37	deceased	deceased	deceased	deceased	deceased
38	deceased	deceased	deceased	deceased	deceased
39	deceased	deceased	deceased	deceased	deceased
40	deceased	deceased	deceased	deceased	deceased
41	deceased	deceased	deceased	deceased	deceased
42	deceased	deceased	deceased	deceased	deceased
43	deceased	deceased	deceased	deceased	deceased
44	deceased	deceased	deceased	deceased	deceased
45	deceased	deceased	deceased	deceased	deceased

Table 3: In comparison to the medium hydroponic sponge, Pool noodle had a slightly better but still the same result which has caused the plant to wither. Using the kratky method it lasted for only 9 days just 3 days after the hydroponic sponge. This is because of the lack of water retention. Pool noodles are made of foam and have a low capacity to hold water, which is an essential element for plant growth in hydroponics. This makes them unsuitable for the Kratky method, which relies on a large body of water to support the plants. As it was used as a floatation device it lacked the source of water which eventually caused the plant to die. Overall, the pool noodle had promising growth, it had grown faster within a short amount of period, this highlights that pool noodles are essential for other systems but in our case not a favorable set up for Kratky.

Coco Peat Growing Medium used in a Hydroponically Grown Lettuce

Table 4 reveals the data of how the Coco Peat growing medium would affect the growth and development of a hydroponically grown lettuce.

Table 4 Coco Peat Growing Medium used in a Hydroponically Grown Lettuce

DAY	DATE	Height (cm) WHOLE	No. of Leaves	Height (cm) STEM	Height (cm) ROOTS
1	Jan-16	1.2	2	1	0.2
2	17	1.4	2	1	0.2
3	18	1.4	2	1.2	0.3
4	19	1.4	2	1.2	0.5
5	20	1.8	2	1.2	0.5
6	21	2.1	2	1.3	0.8
7	22	2.1	2	1.3	1.1
8	23	2.2	3	1.5	1.2
9	24	2.3	3	1.5	1.3
10	25	2.4	3	1.5	1.5
11	26	2.9	3	1.5	1.7
12	27	3.2	3	1.6	1.8
13	28	3.5	4	1.7	2.0
14	29	3.8	4	1.7	2.1
15	30	4.3	4	2.0	2.3
16	31	4.6	4	2.3	2.5
17	Feb-1	5.3	4	2.6	2.6
18	2	5.7	4	3.0	2.7
19	3	6.4	5	3.5	2.9
20	4	7.1	5	4.0	3.0
21	5	7.6	5	4.1	3.2
22	6	8.2	5	4.5	3.4
23	7	8.6	5	5.0	3.6
24	8	9.2	5	5.5	3.7
25	9	9.6	5	5.9	4.0
26	10	10.3	5	6.2	4.2
27	11	10.8	5	6.4	4.3
28	12	11.2	5	6.8	4.3
29	13	11.9	6	7.1	4.4
30	14	12.2	6	7.5	4.4
31	15	12.5	6	8.0	4.5
32	16	12.8	6	8.2	4.7
33	17	13.1	6	8.6	5.0
34	18	13.4	6	9.2	5.2
35	19	13.7	6	9.5	5.3
36	20	14.1	7	9.8	5.4
37	21	14.3	7	10.2	6.0
38	22	14.6	7	10.6	6.2
39	23	15.1	7	11.1	6.4
40	24	15.24	7	11.7	6.5
41	25	15.3	7	12	6.5
42	26	15.3	7	12	6.6
43	27	15.3	7	12	6.6
44	28	15.3	7	12	6.6
45	Mar-1	15.24	7	12	6.6

Table 4: In terms of the growth and development of the plant, table 4 is noteworthy. In this setup, coco peat medium is utilized. The coco peat medium began strongly over a period of no more than 45 days, and as the days went on, it continued to grow steadily. A small amount of growth occurs every day, ranging from a minimum of.2 centimeters to a maximum of 7 centimeters. This is because coco peat has excellent water retention properties and can hold up to 10 times its weight in water. Coco peat also provides excellent conditions for root growth and development, allowing plants to establish a healthy and strong root system. Overall, this demonstrates how a healthy plant continued to grow over a 45-day period with the usage of the kratky and the medium coco.

DISCUSSIONS

This chapter discusses how the experiment's results have changed over time. It also discusses the scientific ideas at play and the various factors that affected how the experiment was carried out. In addition, it describes how the experiment has continued and suggests ways to make it and the research it supports better.

3.1. Trend of Results

After conducting the experimental stage of the research, the results showed that Plant A (rockwool medium) gave us the best results as an alternative growing medium of hydroponically grown plants. This is supported by the results of having the final height of 15.24cm, number of leaves of 8, stem height of 12cm, and a root height of 6.35cm. Followed by Plant C (Pool Noodle Medium) as the second best growing medium alternative with the results of 2 cm as final height, number of leaves of 3, stem height of 1.5cm, and root height of 1.3cm. Concluding that rockwool Medium is the best alternative in growing hydroponically grown plants.

3.2. Scientific Explanation

Rockwool is preferred as a growing medium in hydroponics, this is supported by “Hydroponic cultivation of lettuce using different substrates and irrigation intervals” which is our mother theory that supports the evidence of rockwool as the better medium for hydroponically grown lettuce using the Kratky method in a tuna box. Rockwool for hydroponic lettuce production, and optimization is viable for balance yield and water use efficiency. Another Study by the "Performance of Lettuce (Lactuca sativa L.) Under Soilless Cultivation System Using Different Growing Media and Irrigation Regimes". It stated that The results showed that the lettuce grown in rockwool had significantly higher shoot length, fresh weight and dry weight as compared to other growing media. In the researchers’ study, rockwool is a suitable growing medium for

lettuce production and daily irrigation is recommended for optimal yield. In addition, a study the of the effects of hydroponic medium and nutrient solution on growth, yield, and quality of lettuce resulted that lettuce grown in rockwool had the highest growth rate, yield, and quality, our study suggests that rockwool is the most suitable hydroponic medium for effective lettuce cultivation. Overall it is the best alternative due to the characteristics of rockwool medium which would be having a high water absorption rate. Lastly, rockwool medium is eco-friendly and financially affordable.

3.3. Validity

The independent variables consisted of growing mediums; foam noodles, hydroponic sponge and rockwool. Dependent variables included the lettuce (Lactuca Sativa) and seedling's plant growth. Constant variables included the temperature of the environment, amount of sunlight and water, nutrient solution, type of plant, and method of hydroponic set-up (Kratky method in a Tuna box)

3.4. Reliability

Reliability of the results was ensured by having a total of 24 plants categorized through 6 plants per growing medium (each growing medium has 2 sets with 3 setups of the growing medium on 1 tuna box and the other set with another 3 setups of the growing medium as an ideal sample space) including the constant which is Coco peat to ensure that the results would be same or similar ensuring that the results of our research is reliable.

3.5. Possible Improvements

Possible changes and improvements which could be made on the research is about adding more growing mediums. These implementations may open up to further results and possibilities and could give us different and better results than that of the current research. By adding more possible growing mediums, we could further discover a better growing medium aside from what our research has found out. This result and discovery may lead to further innovation and could help our society and economy to a better sustainable future.

4. SUMMARY, CONCLUSION, AND RECOMMENDATIONS

This chapter presents the study's summary, findings, conclusions, and recommendations.

4.1. Conclusion

Rockwool, hydroponic sponges, and pool noodles. These growing mediums were tested to determine which was most efficient at growing lettuce. The researchers were able to identify which is preferred and is best for hydroponics and growing lettuce with the help of the example of the lettuce growing in a coco peat medium. The study's findings show that utilizing Rockwool has the same or better impact as using Coco peat and produces superior results to using the other mediums. However, Rockwool is eco-friendlier in a way that 50 pieces of its cubes that can fill 50 Styrofoam cups. 1 kilo of Coco peat costs 90 pesos, and it can only fill 7 cups wherein 7 kilos or 630 pesos will be spent. Pool noodles that cost 143 pesos for 1 long pool noodle that can be cut for 20 pieces can fill 20 cups, but it does not ensure the safety of the plant. With hydroponic sponge, it costs 50 pesos for 50 cubes that can fill 50 cups but none grows out of this medium.

4.2. Recommendations

According to the study's findings, rockwool is preferred for use in hydroponics for growing plants like lettuce for many reasons. First, rockwool is a porous substance that has high water retention and good airflow. This keeps the water and oxygen levels in a healthy range so that plant roots may grow. Second, since rockwool has a pH of 7, it has no major impact on the pH of the nutrient solution used in hydroponics. Because of this, gardeners or future researchers can more easily regulate the pH levels of their fertilizer solution. Lastly, because Rockwool can be recycled several times, it is a more environmentally friendly material for hydroponic growing. Between usage, it may be cleaned and sterilized to avoid the growth of harmful microorganisms. Overall, Rockwool provides an excellent balance of water retention, air circulation, pH neutrality, sterility, and reusability, making it an ideal choice for future researchers. The limitations of this study allow future researchers to study other types of mediums making our Rockwool an addition to the control group. The following are the suggested future studies:

1. Future researchers to find alternative hydroponic planting methods that are efficient and effective on a particular growing medium.
2. Hydroponic cultivators to use the DWC (Deep Water Culture) method of planting for pool noodles and hydroponic sponge.
3. Future researchers to make use of other alternative growing mediums other than Rockwool, hydroponic sponge and pool noodles.

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