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The Effectiveness of the Different Brands of Nutrient Solution Used on Hydroponically Grown Brassica Oleracea Var. Capitata (Cabbage)

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Abstract: This study examines the growth of cabbages in relation to the various brands of nutrient solutions used to identify the best elements that ensure efficient plant growth. Studies show that plants need certain nutrients to boost growth and maintain life, such as nitrogen, phosphorus, potassium, sulfur for successful growth and copper, manganese, zinc, iron, and more to treat deficiencies.

The researchers thus have decided to compare different brands to identify the best nutrient solution to use in a hydroponics set-up. However, ingredients of urea and complete nutrient solutions experimented may affect the results of the study, with urea having nitrogen, and complete having nitrogen, phosphorous, and potassium. The researchers did not manipulate the nutrients and had standardized measurements for the solutions and water given to the plants.

To identify the ideal nutrient solution, the researchers used three set-ups, urea, complete, and without solution with three (3) plants each to show the growth within 21 days. Every plant received equal amounts of water and sunlight, the only variables being the nutrient solutions. The results revealed that 1 plant with complete solution withered, all plants with urea shriveled, and all the plants with no nutrient solution survived and grew continually.

The results showed that growing conditions without nutrient solution have the leading effects in the plant's growth. Therefore, is the most effective method in a hydroponics setup. The findings of this study will contribute to agricultural, economic, and healthcare industries for us to efficiently grow and utilize the medicinal and health benefits of cabbages.

Keywords: Hydroponics, nutrient solution, Cabbage.

INTRODUCTION

1.1 BACKGROUND OF STUDY

The United Nations declared soil finite and predicted catastrophic loss within 60 years. The world needs soil for farming, water filtration, climate mitigation, ecosystem services, health care and more. (Miller & Jacobson, 2022) As the world continues to evolve, various societal factors or sectors have been greatly affected, including the agriculture sector. Because of the different attempts at modernized approaches (construction of new buildings, houses, and the like), an area or space to plant trees and various kinds of plants is impossible to find.

Without soil, how can farmers sustain plants? How can plants acquire its needed nutrients without using its basic needs? This can be made possible through Hydroponics. (1) In Hydroponics, the nutrients are instead made available by mixing it with water. A nutrient solution is created as an alternative to soil as the plant's primary source of nutrients. Water and nutrients are combined before being placed into the setups or treatments. (2) Hydroponic flowers, herbs, and vegetables are planted in inert growing media and supplied with nutrient-rich solutions, oxygen, and water. [Robinson, 2019] Plants cultivated hydroponically can be grown in a variety of configurations and with a variety of tools, but they all use nutrient solutions to promote and accelerate the plant's growth. One study presented that cabbage, or *Brassica oleracea var. capitata* is one of the easiest plants to cultivate hydroponically.

According to the Philippine Hydroponics Development Corporation (PHDC), around 120 hydroponic farms currently operate in the Philippines, with an annual production capacity of 800 metric tons. (Brosas, 2023) Philippines is regarded as a top location for hydroponic farming because there is an abundance of water and sunlight here. In addition, because it is more profitable and practical than traditional farming, hydroponics is determined to be the most productive method for the majority of Filipino farmers. In fact, Cebu has opened its doors to vertical farming, which includes the hydroponics approach. Vertical farming, by definition, involves growing a plant inside a greenhouse found in a skyscraper or on surfaces that are inclined vertically. The local government sees this method as a solution to Cebu's existing urban agriculture challenges, particularly in the production of cabbages, because it not only meets the body's nutritional needs but also provides a source of income for most Cebuano farmers.

Vertical roots states that Hydroponics is a way to skip the soil, sub in a different material to support the roots of the plant, and grow crops directly in nutrient-rich water. . Hydroponics is a method of planting that does not need soil and can incorporate a growing media such as vermiculite, coconut coir, or perlite. It employs a nutrient solution to deliver the nutrients that the plants require in order to develop and produce healthily. Furthermore, there are two types of hydroponic growth systems: liquid hydroponic systems and aggregate hydroponic systems. Farmers would have a better probability of having bigger yields or productions as a result of this plant growing approach. But, despite its obvious benefits, its principal negative could be the strict regulation of irrigation and the cost of installation.

So, how do different nutrient solution brands influence a hydroponically produced Cabbage plant? Depending on their properties, different nutrient solution brands have varying effects on plants. Other plants may find a certain solution to be overly sensitive, while others may not. Other nutrient solutions may also cause a plant to wither or reduce its chances of growing. Noting which solution brand best suits a plant is vital since it ensures that the plant's required nutrients are obtained and allows the plant to grow healthily with fewer lapses. If the most appropriate brand is utilized, plant production will be higher than usual. Farmers will not have the need to consider what they can do to improve or modify the nutrient solution since they are confident that it is doing its job well. The farmer's role here is to ensure that the nutrient solution is correctly poured and that the supplies utilized are appropriately stored.

1.2 OBJECTIVES OF THE STUDY

Climate Change is a primary cause in numerous tampers evident within the agricultural sector of the country. With the Philippines under constant heat due to its location, drought is an unbroken evidence of water stress in the plant production. In the severe alterations of soil health, nutrients cannot be transported to different plant embodiments without water absorbed by the soil. This highlights the harmful effects that deter the plant production in the local agriculture if nutrient supply for each crop is limited and unresolved. The rhizosphere is a complex environment where roots interact with physical, chemical and biological properties of soil (Richardson et al., 2009). Most variables modify if soil is removed as a component in growing vegetables. With soil, roots are given a firmed ground to stand and absorb nutrients given off by fertilizers and nutrient solutions. However, its absence will result to the method of a soil-less agriculture through hydroponics. Soil is removed as a growing component, and nutrients absorbed by the vegetable primarily depends on the water supply, and the brand of nutrient solution it utilizes. The nutrients within the cabbage are beneficial to many sectors of the Filipino populace emphasizing the higher necessity of its successful growth. The minerals that improves the efficient growth of cabbage production matters as they are the building blocks toward the accomplishment of physiological and biochemical processes observed by the plant. These processes assist the plant to functionally react to drought stress experienced by the localities and its defense mechanisms against turbulence period of growth.

In the search of finding the nutritional components which will allow a cabbage plant to effectively grow and be harnessed, this study aims to conduct an experiment on what nutrient is a sufficient necessity of a hydroponically-grown cabbage in its plant prosperity based on the physical qualities of a cabbage affected, namely: leaf quantity, plant height, and stem height. At the same time, it addresses the following objectives:

1.) What is the effect of Complete Nutrient Solution to the growth development of cabbage plant in terms of :

a. Quality of the leaves

b. Number of Leaves

c. Height of the Plant

2.) What is the effect of Urea Nutrient Solution to the growth development of cabbage plant in terms of :

a. Quality of the leaves

b. Number of Leaves

c. Height of the Plant

3.) What brand of nutrient solution is suitable in enhancing the growth development of hydroponically grown cabbage?

1.3 SIGNIFICANCE OF THE STUDY

This study aims to determine the change in the holistic growth of cabbage at varying room temperatures and will gain more information that will benefit the following units:

Cancer patients. Studies show that cabbages contain compounds like diindolylmethane and sulforaphane. Diindolylmethane has shown potential in protecting healthy tissues from radiation during cancer treatment and sulforaphane has been found to hinder histone deacetylase, enzymes studied to affect the growth of cancer cells. The biological reactions shown by the testing will allow us to produce quality cabbages that can be used in cancer treatment.

Nutrition, Healthcare, and Alternative Medicine. Cabbages are rich in antioxidants and are known to have many compounds that assist in reducing inflammation, improving digestion, lessening the risk of diseases, and improving overall health. The product of this experiment can potentially yield better opportunities for us to maximize the potential of cabbages in medicinal applications.

Farmers. The developments formed by this investigatory research will deduce the ideal nutrients that cabbages will grow the best in and will upgrade the quality of the production of cabbage harvest.

Agriculture. The outcome of this study could provide better, thriftier, and easier methods of farming cabbages that will allow for speedier but still high quality harvests.

Home gardening. The conclusion of our procedure could increase the potential of indoor gardening, thus creating more opportunities for regular people to build their own hydroponics set-up and grow sustainable and affordable food at home.

Economy. Through our testing and analysis, we can develop smarter and cheaper options for growing cabbages which can then be adapted by larger industries so that they can produce larger quantities of produce using a lower budget. Thus, also reducing the prices of cabbages in the market. Overall, it can be beneficial for both the sellers and the buyers as it is more sustainable when we can ensure high-quality goods at more affordable prices.

1.4 SCOPE AND LIMITATIONS

This study focuses on the Kratky method which utilizes the following materials [both in the planting and experimentation stage]: cocopeat, *Brassica oleracea var. capitata*, cutter, insulated foam, rubber band, soldering iron, soda bottles, mL of water, mg of nutrient solution, and the two (2) brands of nutrient solutions which are urea and complete. In the experimentation stage, three setups or treatments will be presented. The researchers will apply or execute the following: (T1) No fertilizer will be applied. (T2) 50 grams of dissolved urea fertilizer will be applied. (T3) 50 grams of a dissolved complete fertilizer will be applied. Using these setups, researchers can directly identify or gather data as to which solution is the most and least effective for the cabbage plant to grow.

While this research may be deemed useful in assisting individuals in determining which nutrient solution brand suits a cabbage plant, it does not ensure that the results of the experiment on the cabbage will be equal to the results of the experiment on other types of plants. Because each plant has its own characteristics, what is considered acceptable for the cabbage plant may not be suited for the other plants. Because their properties differ from those of the cabbage plant, the solutions described here may be ineffective and sensitive for other plants. Furthermore, while there are numerous nutrient solutions accessible, the most effective nutrition brand solution has yet to be discovered. This merely means that the best nutrient solution for all sorts of plants has yet to be identified, as this study solely focuses on cabbage.

1.5 RISK ASSESSMENT

Hazards and associated harm	Risk Level	Precautionary measures
A cutter is sharp and can cause wounds.	Low	Use the cutter cautiously and properly set it aside after using. Only use sharp cutters without rust for efficient cutting. Firmly hold the material being cut to avoid slipping and cutting oneself.
A soldering iron is hot with a pointed tip and can cause burns and lacerations.	Medium	Wait for the iron to heat before using. Wear protective gear like gloves, goggles, and a lab gown to prevent burns and injuries. Slowly poke the bottle to create slits. After using, let the soldering iron cool down in a safe space and store it once it loses heat.
Cocopeat is a mixture of elements with pointy materials or twigs that can cause splinters.	Low	Wear gloves when handling the cocopeat to avoid cuts. Keep in safe storage spaces to avoid stepping on it.

REVIEW OF RELATED LITERATURE

Hydroponic agriculture has grown in popularity in recent years as a result of its several benefits over traditional soil-based agriculture. It offers a more environmentally friendly, efficient, and accessible method of growing crops, which can aid in addressing some of modern agriculture's difficulties, such as water shortages, land degradation, and climate change. However, in order to expand the number of people who benefit from this type of arrangement, we need to figure out what kind of nutritional solution works best.

The study's goal is to examine the effectiveness of several brands of nutrient solutions used on hydroponically grown cabbage. This section provides a short review of the various studies and other literary works that are relevant in making this research that may be classified into the following parts:

I. Hydroponic Nutrient Solution Easy Guide

II. Hydroponics Systems: Nutrient Solution Programs and Recipes

III. 8 Steps to Master Hydroponic Nutrient Solution

IV. Hydroponic Nutrient Solution Basics

V. Hydroponic Nutrient Solution – The Essential Guide

VI. Hydroponic Nutrient Chart - Guide

VII. How to Make a Hydroponic Nutrient Solution at Home: The Ultimate Guide

VIII. Making Your Own Homemade Hydroponic Nutrients

IX. Essential Plant Nutrients For Your Hydroponic Systems

X. NPK and Nutrient Solution

XI. Role of Plant Nutrients in Plant Growth and Physiology

XII. Mineral Nutrition and Plant Growth Response to Climate Change

XIII. Acquisition of phosphorus and nitrogen in the rhizosphere and plant growth promotion by microorganisms

XIV. A Review On the Science of Growing Crops Without Soil (Soilless Culture) – A Novel Alternative For Growing Crops

XV. Plant growth under drought stress

XVI. Fresh Water Leaching of Alkaline Bauxite Residue after Sea Water Neutralization

2.1 Hydroponic Nutrient Solution Easy Guide

The theory of the significance of each nutrient needed in a nutrient solution by Courtney, A (n.d), states that "When growing plants with hydroponics, you must provide everything that your plant needs to grow or you will run into problems that will cause your plants to struggle or become unhealthy." The way to go about the nutrients needed is to categorize these nutrients into macronutrients and micronutrients. The elements nitrogen, phosphorus, and potassium are the three primary and the most needed-in-high-quantity nutrients that every plant needs. Additionally, the article also states that "The remainder of the nutrients which a plant needs to grow and thrive must be obtained by absorbing them through the roots. This is why it is so essential in hydroponics to supply the right balance and quantities of nutrients in the nutrient solution." To look further more into these, here are the importance of each element that should be included in a hydroponic nutrient solution: (1) Nitrogen is needed in order to make the plants grow into their fullest potential, as well as the formation of its leaves and stems. (2) Phosphorus is essential for the building of healthy roots, and ensures that the flowers and seeds of the plant forms properly. (3) Potassium has many responsibilities, it is responsible for the production of ATP (a source of energy for the plant), activation of the stomata within the leaves, as well as regulate the chlorophyll present within those leaves. (4) Magnesium is important for the production of chlorophyll that produces energy for the plant to grow. (5) Calcium is very important in the production and structure of cell walls; the tips and edges of the plant's leaves will often fail to grow, turn brown, and die, if the plant lacks of calcium. (6) Sulfur is vital for the plant's proteins, it is responsible for the making of root nodules and chlorophyll, as well as it can affect the taste and smell of some vegetables. (7) Iron is major factor in the production of chlorophyl, that boosts the level of iron which results to the plants being greener and vibrant. (8) Manganese has various of involvement within the plants, it is vital in respiration, photosynthesis, and nitrogen processing, as well as it is important in improving root disease resistance and pollen germination. (9) Zinc acts as a catalyst for protein synthesis and also has an important role in stem elongation. (10) Copper is also an important catalyst of numerous chemical processes in plants; it is important in plant metabolism and respiration. (11) Boron is needed in order for plants to produce new cell walls and for the cells to be able to successfully divide. and (12) Molybdenum which is only needed in extremely small quantities to be able to help in the production of numerous proteins as it is an important catalyst.

2.2 Hydroponics Systems: Nutrient Solution Programs and Recipes

According to a study entitled "Hydroponics Systems: Nutrient Solution Programs and Recipes", in hydroponic systems, most plant nutrients are supplied through nutrient solutions (Sánchez et al., 2021). Basic approaches to creating nutrient solutions are fertilizer programs, recipes, and complete fertilizers." These approaches have their respective characteristics, definitions, disadvantages, and advantages. However, they have one goal which is to create effective nutrient solutions for hydroponic systems. Firstly, fertilizer programs are said to consist of a complete fertilizer amplified or supplemented by macronutrients. Note that the supplementation given depends on the stage of plant growth. One example stated in the article is the program provided by "Hydro-Gardens for hydroponic tomatoes". To make a nutrient solution in such program, "it is supplemented with calcium nitrate and magnesium sulfate" Sánchez et al. (2021). In this regard, Fertilizer Programs are convenient to use but individual nutrients are not easily adjusted (if ever we need to add or discard a supplement). Secondly, Nutrient Solution Recipes have an indicated amount for each nutrient that is to be added to the solution. An example stated in the article is the "Modified Sonneveld Solution Recipe". The growers or researchers are given the opportunity to choose which fertilizer will they use to create a nutrient solution. In addition, certain calculations (according to the number of nutrients present in fertilizer and the amount stated in the recipe) are required in this kind of basic approach to ensuring definite and concrete plant growth. Contrary to Fertilizer Programs, this approach allows easy adjustments towards the nutrients. Lastly, we have the Complete Soluble Fertilizer Approach which includes micronutrients to provide nutrients to their hydroponically grown crops. "Using this approach, nutrients are usually applied based on the nitrogen needs of the crop." Sánchez et al. (2021). Among the stated approaches, this is the simplest and most convenient one but using this alone does not provide the right and balanced amount of needed nutrients for the plants. Furthermore, nutrient solutions can be given to the plants through normal strength or concentration. As stated, "common concentrations are 50-, 100- or 200-times normal strength" Sánchez et al. (2021). This is dependent on other factors such as the injector capabilities themselves. When nutrient solutions are concentrated, this can influence some nutrients to form precipitates that can affect the drip lines.

2.3 8 Steps to Master Hydroponic Nutrient Solution

There have been numerous studies that have explored different characteristics and components of nutrient solutions. The theory by Ketan (2021) states that "Basically, a hydroponic nutrient solution is a mixture of all the essential elements required for the healthy and sustainable growth of the plant and is also called a growth medium." (Note that most plants have 17 essential elements). Firstly, a nutrient solution is said to be mainly made up of the essential elements' soluble salts. In this regard, the 17 essential nutrient elements are divided into 2 categories: Macronutrients (carbon, hydrogen, oxygen, nitrogen, phosphorus, potassium, calcium, magnesium, sulfur, iron, copper, chlorine, and nickel) and Micronutrients (Manganese, iron, zinc, boron, molybdenum). It is also stated that a simple type of hydroponic nutrient solution consists of macronutrients, particularly, nitrogen, phosphorus, potassium, calcium, magnesium, sulfur, and some micronutrients. It is also essential to note that there are ideal nutrient solutions developed that growers or farmers can use. Secondly, it is important to constantly monitor and maintain the pH level of the nutrient solution because it can hinder effective and successful plant growth. According to the article, "The optimum pH level for growth is said to be between 5.3 – 6.5." (Ketan, 2021). In addition, the concentration of nutrients should also be maintained because if not, this will lead to nutrient deficiency. Lastly, the temperature of the nutrient solutions also influences the absorption of nutrients in the plants.

2.4 Hydroponic Nutrient Solution Basics

This study is anchored on the concept of the nutrients needed for a plant to live in a hydroponic setup by D'anna, C. (2022) which states that "In hydroponics, plants are not grown in soil, so nutrients must be delivered directly through a watering solution." The nutrients needed are divided into two categories: macronutrients and micronutrients. The nutrients that plants need in large amounts include: carbon, phosphorous, hydrogen, nitrogen, oxygen, sulfur, potassium, magnesium, and calcium; these are otherwise called the macronutrients needed. On the other hand, the nutrients that are still essential but in tiny amounts, are called the micronutrients, that includes: zinc, nickel, boron, copper, iron, manganese, molybdenum, boron, and chlorine. In the words of D'anna, C. (2022), "Without 17 essential elements, plants are unable to build molecules, undergo enzymatic reactions, and complete their life cycle. For hydroponic gardeners, this means that without proper nutrients, the plants cannot produce quality fruit or vegetables or strong plants for transferring to a soil environment."

2.5 Hydroponic Nutrient Solution – The Essential Guide

Regarding the concept of hydroponic systems, this study links the influence of fundamental nutrients on plant development by Trees.com Staff (2022) states that “Meanwhile, without nutrients, plants can still live but will not develop properly.” There are 2 categories of nutrients: Macronutrients and Micronutrients. Firstly, macronutrients are the most important nutrient minerals that must be absorbed in large amounts by the plant. The mentioned macronutrients in the article aid in the growth of the plant, development of the plant’s flowering, fruit, seeds, and roots, reproduction of plants, and cell formation. Secondly, micronutrients are also essential but they are not taken in large amounts. They also help in the plant’s development, nitrogen metabolism, pollination and seed production, nitrogen fixation and helps in the formation of chlorophyll. For some information, a grower or farmer can also create their own nutrient mix but buying one is more recommendable, and there are specific nutrient solutions recommended for some plant types. According to the article, “If you are to choose available solutions for your hydroponic garden, the one thing to keep in mind is that you should get the nutrient designed specifically for Hydroponics only.” Trees.com Staff (2022).

2.6 Hydroponic Nutrient Chart - Guide

GardeningTips.in Staff (2021) tackles the theory of the right nutrient solution for vegetables which states that "Providing nutrients to hydroponic plants is a more complicated process than fertilizing plants growing in soil. A hydroponic nutrient solution allows you to perfectly tailor the delivery of nutrients and optimize plant growth." Additionally, the article also states "With a Hydroponics system, the grower has complete control over the implementation of fertilizer, regarding type and concentration. Also, they can immediately monitor and maintain a relative consistency, providing a nutrient meter is available. The composition of the nutrients is important and there are over 20 elements that are needed for a plant to grow." It is said that without the 17 essential nutrients, the plant cannot grow and function properly, and these essential nutrients can be categorized a macronutrients and micronutrients. These include: Nitrogen, Potassium, Phosphorus, Calcium, Magnesium, Sulphur, Iron, Manganese, Copper, Zinc, Molybdate, Boron, Chlorine, and with the additional beneficial elements which are Nickel, Cobalt, Silica, and Selenium. To regularly fertilize the chosen hydroponics system, the nuntrient mixes: N-P-K mix, Calcium nitrate, and Epsom salt are recommended.

2.7 How to Make a Hydroponic Nutrient Solution at Home: The Ultimate Guide

Based on the theory of how plants grow without soil and weather conditions by Peters, R. (2022), "-growth relies only on the nutrients you ‘feed’ this plant with. Hydroponic nutrients are great helpers when it comes to nourishing plants with the necessary elements for their healthy growth and development." Before anything else, the materials that may be needed in the making of the solution are: pH tester + set for pH adjustment, electric EC meter, measuring cup or cylinder of appropriate size, stirring stick, weighing scales (to the gram), teaspoon (better stainless steel), several mixing cups or other containers, any fertilizer soluble in water, clean (filtered) water, and substances for pH adjustment (potassium hydroxide or phosphoric acid). Moving on, the nutrients plants need is divided into two categories, macronutrients and micronutrients. Both categories of which play a vital part in their respective uses and nutrients that affect the hydroponic plant system. Macronutrients include: calcium, magnesium, nitrogen, phosphorus, potassium, and sulfur (S). While micronutrients that are still essential include: iron, chlorine, boron, manganese, zinc, copper, nickel, and molybdenum. With these in mind, in order for them to be effective, they must have the right concentration, be balanced, and be soluble. In addition to everything laid as a foundation, the article states that "The general composition of a nutrient solution requires calcium, nitrogen, and phosphorus in the form of salts. Mixed, they make the fertilizer’s base. As a result of this mixing, the elements get split into vital elements. So, the basic salts we use for preparing the hydroponic nutrient solution include potassium and calcium nitrates, ammonium phosphate, and magnesium sulfate, otherwise known as Epsom salt."

2.8 Making Your Own Homemade Hydroponic Nutrients

One of the most crucial components in hydroponics is the nutrient solution. The theory of homemade hydroponics by Garden & Greenhouse (2016) states that “Be careful and proceed with caution if you plan to create your own hydroponic solution. This requires experience and a good working knowledge of hydroponics. You can poison your plants by supplying them with excessive amounts of elements or ruin them through element deficiencies.” This indicates that it is important to ensure that the solution has the right mixture of trace elements and salts. For homemade hydroponics, the most important fertilizer salts are the following: Magnesium Sulphate or Epsom Salts (which has magnesium [contributes to the distribution of phosphorus in the plant] and sulfur [causes the production of plant energy]), Potassium Sulphate (which provides potassium [production of energy from photosynthesis] and sulfur), Potassium Nitrate (provides nitrogen [plays a role in the creation of stems, plant cells, and leaves] and potassium), and Superphosphate (provides phosphorus [improves yields] and calcium [assists in the plant’s growth]). In addition, we also have the trace elements that should be added in small amounts and also contributes to the growth of the plants. Some of the trace elements include the following: copper, zinc, manganese, iron, boron, chlorine (this does not need to be added since it can be gained from tap water), and molybdenum. It may be fun and experimental to make our own hydroponic nutrient solution but ensure to try it once you’re not a beginner already because making one entails proper knowledge about the ideals and not.

2.9 Essential Plant Nutrients For Your Hydroponic Systems

According to Steve's (2020) theory of what constitutes a complete nutrient solution for hydroponics, there are two things to keep in mind when choosing the right essential plant nutrients: whether the nutrient solution contains all the components necessary for a healthy growth and whether the nutrient solution is balanced. Hydroponic nutrient solutions are made to be able to provide everything the plant will need without the presence of soil. Nitrogen (N), Phosphorus (P), Potassium (K), Calcium (Ca), Zinc (Zn), Sulphur (S), Iron (Fe), Copper (Cu), Manganese (Mn), Magnesium (Mg), Boron (B), Chlorine (Cl), and Molybdate (Mo) are the essential elements of what makes up for a complete solution. The primary nutrients are Nitrogen, Phosphorus, and Potassium; without the presence of these nutrients, the plants will not be able to survive. Other elements that are beneficial to the growth of the plant include: Silica, Selenium, Cobalt, and Nickel. In addition to the essential elements, see to it that the solution is balanced; be cautious of underfeeding the plant, due to the lack of nutrients contained in the solution, or overfeeding plant, which causes the inability to absorb the nutrients the plant needs. Moreover, be watchful of the pH level of the solution in order to maintain a consistent healthy plant growth as the pH of the nutrient solution helps determine the uptake rate of the nutrients. For hydroponics, the ideal pH level is between 5.5 to 6.5. These are the factors of what makes up the complete nutrient solution for hydroponics.

2.10 NPK and Nutrient Solution

According to AGrowTronics' (n.d.) theory of the primary nutrients (and NPK ratio) present in the nutrient solution, "Nutrient solution is essentially fertilizer. It’s what you give to your plants to provide the nutrients they need to grow. The primary nutrients in this solution are nitrogen (N), phosphorus (P), and Potassium (K). Each of these elements can be referred to as their symbol on the periodic table, and that's true for any other element you add to nutrient solution." The NPK indicates the major parts to create the fertilizer and satisfy the needs of the hydroponic plant. In addition, the NPK ratio refers to the proportions or percentage of each element to make the result (fertilizer) ideal. Let's dig deeper into the 3 most essential hydroponic nutrients (there are still more but let's focus on the main): Firstly, nitrogen helps the plant to supply or produce chlorophyll. Secondly, phosphorus appears to be necessary for the plant's physical growth. Finally, potassium is a nutrient that enables plants to receive other nutrients, and this also plays an important role in photosynthesis. Another fact about the nutrients is that they are salts and are measured by electroconductivity (which occurs by measuring the small electrical currents in the liquid). According to the article, "the elements in fertilizer and nutrient solutions can't always be delivered directly to plants. Instead, they combine with other elements. This creates a salt compound which plants can use, when mixed into a solution." ("NPK and Nutrient Solution", n.d.) On the other hand, note that not all nutrients come from solutions since certain elements come from natural elements (such as air and water). As stated in the article, there are two forms of nutrient solutions: Liquid nutrient solution (which does not need to exert effort because all the needed elements are concentrated and dissolved into water already) and Dry fertilizer (dissolving the mix into the reservoir water in an appropriate amount and this entails more work since one needs to mix together different powders but there are also ready-made ones). Furthermore, nutrient solutions can also be crop-specific formulations which means that there is already a specific nutrient mix for a particular crop or plant. The following are some of the ways to follow to effectively use Hydroponic Nutrient Solutions: When the EC or electroconductivity drops below the ideal and acceptable range, add nutrients, and don't forget to constantly monitor the EC. Also, when adding a fertilizer mix, be accurate in doing so. Try to also use clean water first to mix with the nutrient mix since tap water has its own elements which may affect the composition and result.

2.11 Role of Plant Nutrients in Plant Growth and Physiology

The theory of the essentiality of mineral nutrients in plants based on the criteria of essentiality from Arnon (Criteria of essentiality of inorganic micronutrients for plants. In: Wallace T Trace elements and plant physiology. Chronica Botanica, Waltham, pp 31–39, 1954), is used by Pandey,N. (2018) to explain that the mineral nutrients carbon, hydrogen, oxygen, nitrogen, phosphorus, potassium, calcium, magnesium, sulphur, iron, manganese, zinc, copper, boron, molybdenum and chlorine are essential in major processes of the plant's synthesis. Firstly, it states that these mineral nutrients are considered macronutrients because plants require higher concentration levels from them, about 1 – 150 g per kg of the plant. Secondly, it states that, "The mineral nutrient elements play essential roles such as constituent of cell structures and cell metabolites, in cell osmotic relations and turgor-related processes, energy transfer reactions, enzyme-catalysed reactions and plant reproduction." Lastly, it mentions that the productivity of the plant depends on the efficiency the discharge of the mentioned functions. Overall, it discusses the main functions of mineral nutrients that influence the crop productivity.

2.12 Mineral Nutrition and Plant Growth Response to Climate Change

The theory of plant growth in relation to mineral nutrition uptake and availability as well as its response to climate change is the foundation of this study, which was published in the Journal of Experimental Botany (1992). The study experimented with varied concentrations of CO2 and solution mineral concentrations to simulate climate change to study its effects on plant growth. It explains that "In considering the limitation in plant growth to mineral nutrition it is important to consider both the solution concentration and the total amount of the individual minerals available to the plant", to gauge the response to climate change, especially with the challenge of mineral availability. The study explains that an increase in carbon dioxide concentrations could help improve soil properties for mineral availability due to increase in organic matter deposition in the soil. However, a change in temperature and rain patterns can also affect the soil minerals and possibly decrease it. Overall, the study seeks to gain better understanding of mineral availability and mineral nutrition to support plant growth in the midst of climate change.

2.13 Acquisition of phosphorus and nitrogen in the rhizosphere and plant growth promotion by microorganisms

This paper explicates the theory of the rhizosphere processes and its capacity to uptake nutrients to influence plant growth promotion. It introduces the rhizosphere, an environment where the roots interact with the physical, chemical, and biological properties of soil. First, it begins with explaining the properties of the rhizosphere that are important for the plant to cultivate nutrients. Second, it highlights the characteristics of roots stating, “Roots also interact extensively with soil microorganisms which further impact on plant nutrition either directly, by influencing nutrient availability and uptake, or indirectly through plant (root) growth promotion.” Thirdly, it also considers the interaction of roots and soil microorganisms, specifically mycorrhizal fungi and non-symbiotic plant growth promoting rhizobacteria and its mechanisms that are correlated with plant growth promotion. The study in summary, emphasizes the influence of the interrelationship of roots and soil microorganisms to affect the uptake and availability of nutrients for plant growth promotion.

2.14 A Review On the Science of Growing Crops Without Soil (Soilless Culture) – A Novel Alternative for Growing Crops

This study discloses the theory of growing crops without soil by Malik, Aatif & Iqbal, Kaiser & Aziem, Showkat & Mahato, Prasanto & Negi, Ajeet. (2014). The uprising of soilless planting culture is becoming more relevant due to the limited land for cultivation and the worsening issue of climate change. It states that, “Soilless Culture is the growing of plants that imitate soil-base gardening by using many kinds of growing media as for example inorganic substance, organic substance and synthetic substrates.” It encourages the innovation of soilless growing because it becomes reduces the need for additional chemicals that are used for pest and disease control which are normally used in soil grown crops. Furthermore, it explains that “Plants grown in soil less culture has consistently superior quality, high yield, rapid harvest, and high nutrient content”, therefore supporting that soilless growing is more efficient and practical for growing because of its controlled set-up that can easily be manipulated to produce quality goods. However, it mentions that such success is less likely to be achieved from developing countries due to poor dissemination of technology and lack of knowledge on the systems. The study concludes that for soilless culture to be promoted worldwide, scientifically proven technology and methods must be provided to gardeners to fully utilize potential areas.

2.15 Plant growth under drought stress

This investigation is based on the theory put forth by Abd-Allah, E., Ahanger, M., Ahmad, P., Hajiboland, R., and Morad-Talab, N. regarding the impact of mineral nutrients on plant metabolism. (2016). It first explains that plants undergo environmental stress factors, of which there are agricultural methods to alleviate the impact of these. Then, it introduces mineral nutrients and explains that these play major roles in plant growth, and any deficiency of these can hinder the plant’s potential for growth. It states that, “Mineral elements mediate several physiological and biochemical processes like enzyme activation, osmoregulation, protein synthesis and photosynthesis”. Meaning, that mineral nutrients are vital to help the plant cope with stress factors and encourages the plant’s cycle of growth for its survival. It discusses that, “Proper supplementation of mineral elements to crop plants can contribute to avoid drought stress through their active participation in several defense mechanisms like osmoregulation and antioxidant systems.”

2.16 Fresh Water Leaching of Alkaline Bauxite Residue after Sea Water Neutralization

This research is based on the theory set by Fulton, I., Kopittke, P., Kopittke, R., and Menzies, N. regarding the neutralization of alkaline bauxite residue to produce plant growth mediums. (2009). It states that, “In many alumina refineries, the waste is separated into fine-textured red mud and coarse-textured residue sand (RS)”, a substance that can be used as a medium for plant growing. Furthermore, it states that, “Neutralization of the highly saline-sodic RS with sea water lowers pH, reduces Na saturation, and adds plant nutrients”. However, this must undergo fresh water leaching before being used as a plant growing medium. This process is done because, “The percentage of the effective cation exchange capacity (ECEC) saturated by Na decreased from 71 to 62% due to a reduction in soil solution ionic strength (causing a decrease in the ECEC) and the preferential displacement of Na+ (and K+) from the exchange." In addition, "Fresh water leaching increased pH (leachate pH increased from 8.0 to 10.1)", which contributed to the slow dissolution of the Na-containing mineral sodalite, thus making it more suitable for plant growth because of the added nutrients and improved pH levels that make it more sustainable.

Although there are a number of studies or articles that shows and describes the importance and forms of Hydroponic Nutrient Solutions, the availability of information that states a comparative study about the different brands of nutrient solutions present is limited. The said statement is the aim of this current study. To know what are the different brands that produce or supply hydroponic nutrient solutions. The following research questions are being discussed: (1) What are the different brands of hydroponic nutrient solutions? (2) In terms of characteristics and amplifications, how do these brands differ from each other? (3) How do these brands individually affect the Cabbage plant?

RESEARCH METHODOLOGY

This study highlights the results and analysis garnered when *Brassica oleracea var. capitata* is grown in a hydroponic system over a specified course of time pertaining to the number and color qualities of the plant. Two brands of nutrient solutions are used to test which is the most effective set-up for a hydroponically grown cabbage. The schematic below provides a deeper understanding of the study's overall concept ***(Figure 1)***.

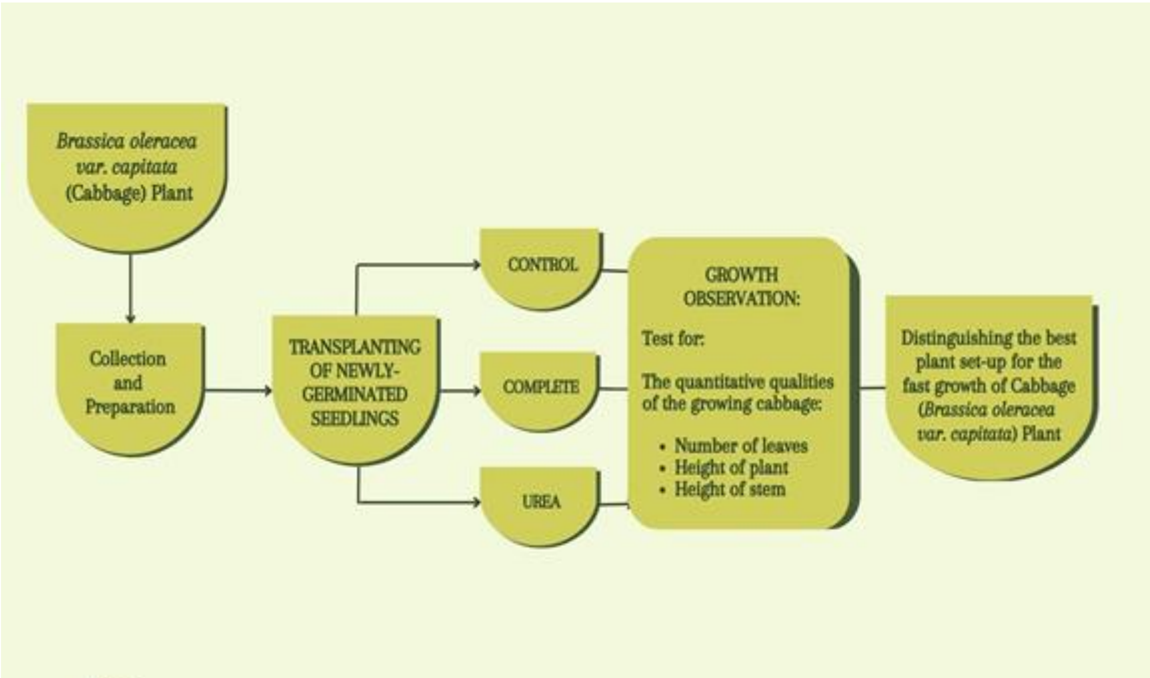

Figure 1.

3.1 Research Design

Brassica oleracea var. capitata are asexually reproductive plants that have been proven to undergo successful growth under a hydroponic system. With that, this study examines the effectiveness of Urea and Complete nutrient solutions to the growth and nutrition of the hydroponically grown *Brassica oleracea var. capitata* (cabbage) by employing quantitative experimental procedure. The researchers first germinated cabbage seedlings and transplanted them onto three set-ups. Two with nutrient solutions (urea and complete) and one without, to conclude the best method of growing the *Brassica oleracea var. capitata* (cabbage) plant hydroponically.

3.2 Research Procedure

The following are the stages followed by the researchers as guides to their experimentation. These phases that may determine the results of the experiment to be conducted are composed of preparation, setting-up, layout, and observation. Through thorough research on relative videos, these are the steps garnered to conduct successful experimentation.

Phase 1: The Preparation of the Materials and Equipment to be Used

As agreed, the researchers decided to focus on the Kratky method. That said, this technique utilizes simple materials in the creation of the pot plants, namely: cocopeat, *Brassica oleracea var. capitata*, cutter, insulated foam, rubber band, soldering iron, soda bottles, 50 mL of water, 50 mg of nutrient solution, and the two (2) brands of nutrient solutions which are urea and complete.

Phase 2: The Formation of the Different Set-ups

There are three types of set-ups in the experiment, one as the control and the other two as the experimental set-ups. In all three, they have similar starting procedures – the formation of the Kratky method. Hence, the following are the preliminary steps. 1) Cut the pet bottle in the evident line near its upper part. 2) Use the soldering iron to create a slit in the upper half of the bottle and the cap. 3) Measure the insulated foam. 4) Wrap the measured insulated foam around the bottle. 5) Secure the foam with a rubber band. 6) Remove the measured and secured insulated foam from the bottle for the time being. 7) Place the nutrient solution and water in the bottom part of the bottle. 8) Situate the cocopeat in the upper part of the bottle. 9) Make space in the cocopeat for the *Brassica oleracea var. capitata* plant by spreading some of it towards the sides so as to create a hole in between. 10) Transfer a growing *Brassica oleracea var. capitata* plant into the newly-made hole of the cocopeat. 11) Put the formed insulated foam back into the bottle.

Phase 3: Designing and Laying Out

After the set-ups are assembled, designing it would follow. In this process, the addition of similar grams of different nutrient solutions will transpire. 50mg of Urea Nutrient Solution will be added to the first experimental set-up and 50mg of Complete Nutrient Solution will be placed in the second experimental set-up. The experimental and control set-ups will be placed outdoors to optimize direct sunlight for its growth. An application of 1.5 inches of water will be provided to every set-up weekly, (Bonnie Cabbage Program, n.d.).

Phase 4: Preliminary Data Analysis

After determining the necessary materials and procedures, the researchers will begin collecting data on the plant's growth. The researchers will examine the size of the leaves, the condition of the roots, the plant's height, and other factors. Data collection would continue indefinitely until the *Brassica oleracea var. capitata* plant has already matured. In line with that, the observations gathered are relative in the given tables below.

Control Set-up (Plant #1)

	Number of Days													
	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Number of Leaves														
Height of Plant														
Height of Stem														

Control Set-up (Plant #2)

	Number of Days													
	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Number of Leaves														
Height of Plant														
Height of Stem														

Control Set-up (Plant #3)

	Number of Days													
	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Number of Leaves														
Height of Plant														
Height of Stem														

Plant #1 with Urea Nutrient Solution

	Number of Days													
	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Number of Leaves														
Height of Plant														
Height of Stem														

Plant #2 with Urea Nutrient Solution

	Number of Days													
	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Number of Leaves														
Height of Plant														
Height of Stem														

Plant #3 with Urea Nutrient Solution

	Number of Days													
	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Number of Leaves														
Height of Plant														
Height of Stem														

Plant #1 with Complete Nutrient Solution

	Number of Days													
	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Number of Leaves														
Height of Plant														
Height of Stem														

Plant #2 with Complete Nutrient Solution

Number of Days														
	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Number of Leaves														
Height of Plant														
Height of Stem														

Plant #3 with Complete Nutrient Solution

Number of Days														
	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Number of Leaves														
Height of Plant														
Height of Stem														

4.1 PRESENTATION

This section covers the analysis and interpretation of the study on how nutritional solutions impact the distinctive characteristics of the *Brassica oleracea var. capitata* plant using the quantitative method. The data acquired from the 9 plants with varied setups and different nutritional solutions seen through the experimental approach is the focus of this chapter. Using the Kratky technique, the researchers are able to observe the plants since it is low-cost and it requires minimal care while delivering a constant supply of water and nutrients to the plant, making it ideal for growing Brassica oleracea var. capitata. With that method, the researchers are able to answer the issue of what nutrient solution is best while growing *Brassica oleracea var. capitata* by collecting the quantitative data. Even though plants require nitrogen, potassium, and phosphorus, which are present in the nutrient solutions that the researchers are using, there is a possibility that certain imbalances occur, causing the plants to wither. Surprisingly, the experiment concludes that the ideal arrangement for growing Brassica oleracea var. capitata is by using no nutritional solution at all. This analysis is critical, particularly for those who benefit this study, such as farmers, sick people, our agriculture, and the economy.

4.2 EXPERIMENTATION DATA

Control Set - Up (Without Nutrient Solution)

Table 1: Plant 1

NUMBER OF DAYS	PLANTS HEIGHT (mm)	NUMBER OF LEAVES	STEM'S HEIGHT (mm)
1	35	2	30
2	35	2	30
3	36.5	2	32
4	40.5	2	34.3
5	44	2 leaves and growing	35.9
6	47.3	3	37
7	51	3	38.7
8	57.5	3	41
9	62	3	42
10	67	3	44.9

11	70.6	3 leaves and growing	46.7
12	74	4	48
13	79	4	50
14	80	4	50
15	80.5	4	50
16	81. 2	4	50
17	81.9	4 and growing	50
18	82. 4	5	50
19	83.3	5	50
20	84.1	5	50
21	85	5	50

Table 2: Plant 2

NUMBER OF DAYS	PLANTS HEIGHT (mm)	NUMBER OF LEAVES	STEM'S HEIGHT (mm)
1	35	2	30
2	35	2	30
3	37.1	2	30
4	39.2	2 leaves and 1 growing	31. 5
5	41.7	3	34
6	46	3	39
7	50.6	3	41
8	58	3 leaves and 1 growing	44
9	63.3	4	48
10	69.8	4	50.8
11	76.4	4 leaves and 1 growing	53.4
12	81	5	55
13	86	5	58.3
14	90	5	60
15	90	5	60
16	91.7	5	61.5
17	93	5 and growing	62
18	94.7	6	62. 8
19	95.6	6	63.4
20	96.2	6	65.7
21	97	6	67

Table 3: Plant 3

NUMBER OF DAYS	PLANTS HEIGHT (mm)	NUMBER OF LEAVES	STEM'S HEIGHT (mm)
1	35	2	30
2	35	2	30
3	37.9	2	32
4	39.8	2 leaves and 1 growing	34
5	43	3	37
6	49	3	41
7	54.5	3 leaves and 1 growing	47
8	60	4	53.6
9	69.9	4	59
10	79	4	64.3
11	88	4 leaves and 1 growing	69.9

12	96	5	73
13	109	5	78.9
14	110	5	80
15	110	5	80.3
16	110	5	81.2
17	110	5	82
18	110	5 and 1 is withering	82.4
19	110	5 and 1 is withering	82.9
20	110	4	83.6
21	110	4	84.4

The first three tables indicate the total measurement of the three *Brassica oleracea var. capitata* for a period of three weeks in a controlled set-up with no nutrient solution being added. Plants are growing in all aspects, including height, number of leaves, and stem height. They are expanding steadily, adding more than 50mm in height, 4 - 6 leaves, and more than 20mm in stem height. All three plants in the controlled setup are growing continuously without the use of the nutrient solution and just with tap water. Plants in a hydroponic arrangement may not thrive solely on tap water, although in some situations, tap water may provide nutrients suitable for the development of *Brassica oleracea var. capitata* in hydroponics depending on its location. There is also the presence of cocopeat, which aids in the development of the plant. Despite its low nutritional content, it contains several features that contribute to the growth of the *Brassica oleracea var. capitata* plant, such as its high water-holding capacity, providing adequate oxygenation to the plant's roots, and its weight being light. Furthermore, these findings show that *Brassica oleracea var. capitata* may grow in a hydroponic setting without the presence of a nutrient solution.

Experimental Set-Up 1: (With Complete Nutrient Solution)

Table 4: Plant 1

NUMBER OF DAYS	PLANTS HEIGHT (mm)	NUMBER OF LEAVES	STEM'S HEIGHT (mm)
1	35	2	30
2	35	2	30
3	39	2	34
4	46	2	38.7
5	57	2 leaves and 1 growing	43
6	65	3	48.7
7	72	3	53.3
8	79	3	55.8
9	88	3 leaves and 1 growing	62
10	96	4	67
11	103	4	70.2
12	111.6	4 leaves and 1 growing	75
13	116	5	78
14	120	5	80
15	120	5	80
16	120.8	5	81.7
17	121.5	5	82. 2
18	122.8	5	82.6
19	123.4	5	83.4
20	124.1	5	84.3
21	125.2	5	85

Table 5: Plant 2

NUMBER OF DAYS	PLANTS HEIGHT	NUMBER OF LEAVES	STEM'S HEIGHT
1	35	2	30
2	35	2	30
3	37	2	31
4	41	2	34
5	49	2 leaves and 1 growing	38.3
6	56	3	43
7	64	3	46
8	71	3	49.8
9	79	3 leaves and 1 growing	54
10	87	4	59.7
11	95	4	62
12	106	4 leaves and 1 growing	68.5
13	109	5	70
14	100	5	70
15	100	5	70
16	101	5	71.5
17	103.5	5	72.3
18	104.6	5	74
19	106.9	5	75.8
20	108.7	5	77.4
21	110	5	78.8

Table 6: Plant 3

NUMBER OF DAYS	PLANTS HEIGHT	NUMBER OF LEAVES	STEM'S HEIGHT
1	35	2	30
2	35	2	30
3	38.5	2	32
4	44	2	37
5	53	2 full and 1 growing	45
6	57	3	50
7	63	3	56
8	65	3	57
9	71	3 leaves and 1 growing	59
10	79	4	61
11	86	4	65
12	94	4 leaves and 1 growing	69
13	108.5	5	77
14	110	5	78
15	110	5	78
16	withering	4 (withering)	73
17	withering	3 (withering)	70 (withering)
18	withered	withered	withered

19	withered	withered	withered
20	withered	withered	withered
21	withered	withered	withered

Tables 4 – 6 show the data from the three Brassica oleracea var. capitata plants grown with the complete solution setup. The results demonstrate that, with the exception of the third plant, which is withering during the third week of observation, all of the plants are growing continually after three weeks. Nutrients, nitrogen, phosphorous, and potassium are all present in the complete nutrition solution. All of these nutrients contribute to Brassica oleracea var. capitata's growth using the hydroponic system since it requires nitrogen to grow and develop its leaves as well as Phosphorus for the production of its heads. Using potassium can also help in the formation of the Brassica oleracea var. capitata's head and also for disease resistance. Despite being full of nutrients, there are a few conditions that may cause plants to die when using this type of nutrient solution, just like what is happening to the third plant. It may be due to nutritional imbalance since too much of one nutrient can harm the plant. Temperature and humidity may also have a role, since high temperatures and low humidity levels can stress plants, making them more susceptible to disease and pests. But, this depends on where the researchers are placing the plants being experimented on. Furthermore, although one plant is withering and the other two plants are flourishing, the whole nutrient solution may still be utilized to plant Brassica oleracea var. capitata in a hydroponic arrangement but it may not be the best one to use.

Experimental Set-Up 2:(With Urea Nutrient Solution)

Table 7: Plant 1

NUMBER OF DAYS	PLANTS HEIGHT (mm)	NUMBER OF LEAVES	STEM'S HEIGHT (mm)
1	35	2	30
2	35	2	30
3	35	2	30
4	34.8	2	29.6
5	32.8	2	27.9
6	31.9	1	26
7	29	1	24. 7
8	27	1	23
9	23	1	21
10	withered	withered	withered
11	withered	withered	withered
12	withered	withered	withered
13	withered	withered	withered
14	withered	withered	withered
15	withered	withered	withered
16	withered	withered	withered
17	withered	withered	withered
18	withered	withered	withered
19	withered	withered	withered
20	withered	withered	withered
21	withered	withered	withered

Table 8: Plant 2

NUMBER OF DAYS	PLANTS HEIGHT (mm)	NUMBER OF LEAVES	STEM'S HEIGHT (mm)
1	35	2	30
2	35	2	30

3	34.6	2	30
4	33.8	2	29.3
5	31	1	27.8
6	29	1	26.3
7	26	1	23
8	24	1	21.8
9	21	1	20
10	withered	withered	withered
11	withered	withered	withered
12	withered	withered	withered
13	withered	withered	withered
14	withered	withered	withered
15	withered	withered	withered
16	withered	withered	withered
17	withered	withered	withered
18	withered	withered	withered
19	withered	withered	withered
20	withered	withered	withered
21	withered	withered	withered

Table 9: Plant 3

NUMBER OF DAYS	PLANTS HEIGHT (mm)	NUMBER OF LEAVES	STEM'S HEIGHT (mm)
1	35	2	30
2	35	2	30
3	34.3	2	30
4	31.8	2	28.7
5	30	2	27.1
6	28.4	1	26
7	26.1	1	25
8	24.7	1	23.4
9	21.9	1	20
10	withered	withered	withered
11	withered	withered	withered
12	withered	withered	withered
13	withered	withered	withered
14	withered	withered	withered
15	withered	withered	withered
16	withered	withered	withered
17	withered	withered	withered
18	withered	withered	withered
19	withered	withered	withered
20	withered	withered	withered
21	withered	withered	withered

The measurement of three *Brassica oleracea var. capitata* plants using the Urea Solution is present in the 7th - 9th table. All three plants are barely surviving the second week of observation before withering in the third. Nitrogen is abundant in the Urea solution. All plants may have died due to nutritional imbalance since *Brassica oleracea var. capitata* requires a balance of nutrients to grow effectively, and an excess or lack of any nutrient can cause stress or injury to the plant. Because urea only supplies nitrogen, it is critical to ensure that all of the other essential elements are present in sufficient proportions in the nutrition solution to promote *Brassica oleracea var. capitata*'s development. Furthermore, the experiment findings conclude that the Urea solution is not suitable for planting *Brassica oleracea var. capitata* in a hydroponic setting.

The above discussions imply that both the Complete and Urea nutrient solutions may boost a plant, specifically *Brassica oleracea var. capitata*'s development, however, the plant still withers in the end. The optimum method to plant *Brassica oleracea var. capitata* is using a setup with no nutritional solution. This is due to the fact that, despite the lack of a nutrient solution, the plants in the controlled setup are the only ones that are growing continuously throughout the experiment. The nutrients in the tap water and the presence of coco peat, which helps sustain plant growth, are the variables that contribute to the plant's development. The research's findings are consistent with previous studies which found that plants may be grown hydroponically using tap water even in the lack of fertilizer (Sundar et al., 2021). The growth of the plant in the study by Ruangrak et al. (2023) shows likewise results and it reveals positive results when substituting fertilizer solution with tap water. This indicates that tap water has a larger potential for boosting plant development in a hydroponic setting, even if no nutritional solution is present.

4.3 VALIDITY

The validity of this study was established by presenting three different setups or treatments with varied variables and assessments. The most efficient approach for growing a hydroponically grown cabbage was identified using various arrangements. The experiment's independent variable is the brand of nutrient solution, whereas the dependent variables are the number of leaves, stem height, and plant height. The factors under control were the amount of water, the amount of soil, and the temperature. These variables aided in confirming the legitimacy of the obtained data, proving the accuracy of the research itself. Furthermore, the validity was further verified by noting and listing the findings identified in the observations done every week.

4.4 RELIABILITY

In order to prove reliability, the researchers carried out the experiment through study and repetition. Since the creation of the materials employed in a hydroponic setting and the germination of the plants, which was done twice, the researchers have taken great care to assure the experiment's reliability. The plant was measured every day for three weeks to confirm that there was also the existence of the plant's growth and development. Other variables were also examined to ensure that the plant received what it needed. The data collected by the researchers during the experiment was documented in a table that gives a comprehensive evaluation of how the data was gathered as well as the evaluation of the outcomes. The usage of the table for data collection allowed the researchers to easily understand the results based on the recorded status of the plant each day, as well as to assist the researchers in analyzing the state of the research. The table also aided in the brief creation of the study's conclusion. Certain related studies were also used to further investigate the research's reliability, such as hydroponics as a setup in growing crops without soil (Malik et al., 2014), the effect of nutrient solutions in a hydroponic setup (D'anna, C., 2022), and the required nutrients for hydroponically grown plants (Steve, 2020). Furthermore, the reliability of the research was assured by the use of measurement repetition, data gathering, and literature research.

4.5 DISCUSSION

The findings of this study suggest that the growth of *Brassica oleracea var. capitata* in a hydroponic setup may be influenced by the kind of nutrient solution it has. Using different nutrient solutions while planting cabbage plants in a hydroponic setting had a quantitatively significant effect. The plants exposed to the various nutrient solutions withered at the conclusion of the experiment, whereas the plants exposed to no nutritional solutions flourished and thrived continuously. According to the statistics, the most successful method of growing cabbage in a hydroponic setting is to use no nutritional solution at all. The findings of the study are consistent with prior studies that indicated that nutrient solution has a substantial influence on a plant since it is the primary source of nutrients essential for plant growth and development. (Ketan, 2021).

The study aims to determine which nutrient solution is the most successful, whether Urea or the Complete solution, however, rather surprisingly, the most effective setup for growing Brassica oleracea var. capitata is the controlled one, which did not contain any nutrient solution. Despite the fact that the plants grew constantly in both nutrient solutions during the first week of observation, they began to wither in the second week and perished by the third week. This surprising finding contradicts the hypothesis since the research demonstrates that *Brassica oleracea var. capitata* plants can be grown well in a hydroponic arrangement even when no nutritional solution is given.

In addition, the research has certain limitations or weaknesses. The study looks at three different setups or treatments, as well as the presence of two (2) nutrient solution brands, and how they affect the development of the cabbage plant. However, this does not guarantee that the outcome of the experiment on the cabbage will be identical to the other types of plants. Because all plants have unique qualities, what is thought acceptable for the cabbage plant may not be suitable for the other plants. Furthermore, there are several nutrient solutions available, which is why the most effective nutrient brand solution has yet to be found. On a positive note, these constraints had no effect on the flow or outcome of the research; future studies could also include additional setups demonstrating the effect of similar nutrient solution brands on two different plants. Through this, individuals will be able to determine which solution has a higher efficacy rate, allowing for better plant production and outcomes.

The outcome demonstrates that a nutrient solution is essential because it allows the plant to grow healthily with its required nutrients. Furthermore, it can be seen that both the Complete and Urea nutrient brand solutions are capable of accelerating the growth of a plant, particularly the Brassica oleracea var. capitata. The data also shows that the best way to plant a cabbage is in a control setup with no nutritional solution. With that said, this study is beneficial to the agricultural sector because it allows for the rapid growth of healthy plants for the production of food, which also benefits the economy. Furthermore, if farmers choose the hydroponic method of planting, they will have no difficulty determining what nutrient solution to use for their plants.

CONCLUSION AND RECOMMENDATIONS

5.1 CONCLUSION

This study looked at how different brands of nutrient solutions affect the growth of a cabbage, or *Brassica oleracea var. capitata*. The researchers were able to collect the data required as proof of which setup is deemed successful by using the three different setups or treatments presented. To be more specific, the primary goal of this research is to determine which nutrient solution [between Urea and Complete Solution] will be able to meet the nutritional requirements of the cabbage plant in order for it to grow healthily. Evidently, the study concludes that the most effective setup for growing *Brassica oleracea var. Capitata* is the controlled one that does not contain any nutrient solution. The plant grew continuously in both nutrient solutions during the first week of observation but began to wither in the following weeks. This shows that the *Brassica oleracea var. Capitata* without the use of any nutrient solution, can still grow successfully hydroponically. In addition, the results of this study conclude that the Complete nutrient solution is more effective than the other because the plant took longer, or several days, before it started to wither.

5.2 RECOMMENDATIONS

Based on findings here are a few recommendations to take into account based on the study's findings and conclusion: 1.) Farmers should pour a larger amount of Complete and Urea Solution into the plant to see if it can reduce the plants' tendency to wither. 2.) In order to determine which nutrient solution would actually be the most suitable and efficient, there should be a greater variety of setups or treatments available. 3.) Find out if the nutrient solution alone is the only cause of the plants' withering after a week or weeks of observation. 4.) The Urea and Complete Nutrient solution will be mixed in order to observe possible changes or occurrences within the expirement. 5.) Given the Urea and Complete Nutrient solution, their ratio used will be changed to seek the chances of being balanced to ensure the plant's higher development.

Because this study only looks at the effects of two specific nutrient solutions on Brassica oleracea var. Capitata, it is suggested that additional studies include more brands of nutrient solutions to determine what is truly suitable for this type of plant and which nutrient solution does not cause this plant to wither in the latter part of the observation days. Furthermore, future studies can focus on a variety of plants with similar nutrient solutions to clearly see which specific nutrient solution is the most effective in assisting the plants' development or growth.

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