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STUDENT FIELD PROJECT

"DEVELOPMENT OF PROTOCOL FROM HYDROPONICS CULTURE OF SOME CROP PLANTS"

SUPERVISORS

Dr. M. RAMBABU & Dr. B. VIJAYPAL REDDY

STUDENT RESEARCHERS

1. G.SANDEEP . B.Sc., B.Z.C. –I yr
2. K. SAITEJA. B.Sc., B.Z.C. –I yr
3. M. MANOJ REDDY. B.Z.C. –I yr
4. K. ARJUN. B.Z.C. –I yr
5. M. LOHITHA. B.Z.C. –I yr
6. G. PREETHI. B.Z.C. –I yr

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DEPARTMENT OF BOTANY

CERTIFICATE

This is to certify that the work incorporated in this project *entitled* ***"DEVELOPMENT OF PROTOCOL FROM HYDROPONICS CULTURE OF SOME CROP PLANTS"*** has been carried out by B.Sc. first year students under the guidance of **Dr.M. RAMBABU,** Asst. Prof. of Botany and **Dr.B. VIJAYPAL REDDY,** Asst. Prof. of Botany.

I further certify that the project work done by the students is original, the assistance and help taken during the project work and source of literature is fully acknowledged.

In charge
Dept.of Botany **PRINCIPAL**

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2. We also acknowledge the constant support of our principal **Dr. P.Venkateshwarlu** during the completion of the project.

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INTRODUCTION

"HYDROPONICS" is the growing of plants in a liquid nutrient solution with or without the use of artificial media. It has been recognized as a viable method of producing vegetables (tomatoes, lettuce, cucumbers and peppers) as well as ornamental crops such as herbs, roses and foliage plants. Due to the ban on methyl bromide in soil culture, the demand for hydroponically grown produce has rapidly increased in the last few years.

The word Hydroponics comes from two Greek words 'hydro' meaning water and 'ponos' meaning labor. This word was first used in 1929 by Dr. Gericke, a California professor who began to develop what previously had been a laboratory technique into a commercial means of growing plants. The U.S. Army used hydroponic culture to grow fresh food for troops stationed on infertile Pacific islands during World War II. By the 1950s, there were viable commercial farms in America, Europe, Africa and Asia.

Hydroponics is a new technology. This means that the principles behind hydroponics have been around for years, but the study of it has only been around recently. One of the Seven Wonders of the Ancient World, the Hanging Gardens of Babylon, was believed to have worked with some of the principles that are used in hydroponics. The famed Hanging Gardens of Babylon are believed to have been one of the first mass scale hydroponic projects. The same concept is in use today where floating farms are giving hope to farmers along rivers in Bangladesh, and other areas around the world, that have been hit by massive flooding in recent years. NASA which is an American space association is undergoing various experiments to see how hydroponic produce can manage through the difficulties of space. And see if it will be suitable for astronauts in future space exploration.

Actually this technique was first started by Sir Francis Bacon, a philosopher and William Frederick Gericke has spread his idea that plants can grow in nutrient rich water, not just in soil. Logically, the public didn't believe him. The experiment that proved the public wrong was when he grew a 25 foot long tomato vine using his method alone. Fortunately, his research led into the expansion of the study of hydroponics. He was actually the man who gave hydroponics its name. After his research, the demand for the evolvement of hydroponics wasn't very high; that all

changed in 1925. This was due to the inconvenience of having to maintain big amounts of greenhouse soil

Two German scientists, Wilhelm Knop and Julius von Sachs, created their own experiments which focused on growing plants without soil; these experiments lasted from 1859-1865. They developed systems that ended up growing plants in nutrient rich solutions. Hydroponics, just like everything else, has advantages and disadvantages. It helps make the food we eat, air we breathe, water we drink, and soil we use; much cleaner, it is also environmentally friendly. With hydroponics, you won't need to use harmful pesticides; you can also grow plant anytime of the year (as long as the conditions are right). Growing crops with hydroponics take up less space, requires less work, and are easy to harvest. Some of the disadvantages to using hydroponics are that plants will need to be supervised to insure they are growing properly. You will need to know how to set up the equipment and might even need to manually water the plants (if the water ends up drying out). Out of all of the possible hydroponic system choices, we have chosen this technique to develop the protocol for production of some crop plants.

AIMS & OBJECTIVES

In the present investigation we have developed the protocol for crop plants production through Hydroponics culture. For this process we have planned the investigation on the following objectives….

- Selection of Plant Species for Hydroponics Culture
- Preparation of Hydroponics Nutrient Culture Medium
- Culture of Crop plant in the Liquid Nutrient Medium
- Incubation of Cultured Plants
- Development of Cultured Plants
- Separation of Cultured plants

REVIEW OF LITERATURE

The earliest published work on growing terrestrial plants without soil was the 1627 book 'A Natural History' by Francis Bacon, printed a year after his death. Water culture became a popular research technique after that. In 1699, John Woodward published his water culture experiments with spearmint. He found that plants in less-pure water sources grew better than plants in distilled water. By 1842, a list of nine elements believed to be essential for plant growth had been compiled, and the discoveries of German botanists Julius von Sachs and Wilhelm Knop, in the years 1859–1875, resulted in a development of the technique of soilless cultivation. Growth of terrestrial plants without soil in mineral nutrient solutions was called solution culture. It quickly became a standard research and teaching technique and is still widely used. Solution culture is, now considered, a type of hydroponics where there is no inert medium.

In 1929, William Frederick Gericke of the University of California at Berkeley began publicly promoting that solution culture be used for agricultural crop production. He first termed it aquaculture but later found that aquaculture was already applied to culture of aquatic organisms.

Gericke created a sensation by growing tomato vines twenty-five feet (7.6 metres) high in his back yard in mineral nutrient solutions rather than soil. He introduced the term hydroponics, water culture, in 1937, proposed to him by W. A. Setchell, a phycologist with an extensive education in the classics. Reports of Gericke's work and his claims that hydroponics would revolutionize plant agriculture prompted a huge number of requests for further information. Gericke had been denied use of the University's greenhouses for his experiments due to the administration's skepticism, and when the University tried to compel him to release his preliminary nutrient recipes developed at home he requested greenhouse space and time to improve them using appropriate research facilities. While he was eventually provided greenhouse space, the University assigned Hoagland and Arnon to re-develop Gericke's formula and show it held no benefit over soil grown plant yields, a view held by Hoagland. In 1940, Gericke published the book, *Complete Guide to Soil less Gardening,* after leaving his academic position in a climate that was politically unfavorable.

Two other plant nutritionists, Dennis R. Hoagland and Daniel I. Arnon, at the University of California were asked to research Gericke's claims. The two wrote a classic 1938 agricultural bulletin, *The Water Culture Method for Growing Plants Without Soil,* which made the claim that hydroponic crop yields were no better than crop yields with good-quality soils. Crop yields were ultimately limited by factors other than mineral nutrients, especially light. This research, however, overlooked the fact that hydroponics has other advantages including the fact that the roots of the plant have constant access to oxygen and that the plants have access to as much or as little water as they need. This is important as one of the most common errors when growing is over- and under- watering; and hydroponics prevents this from occurring as large amounts of water can be made available to the plant and any water not used, drained away, recirculated, or actively aerated, eliminating anoxic conditions, which drown root systems in soil. In soil, a grower needs to be very experienced to know exactly how much water to feed the plant. Too much and the plant will be unable to access oxygen; too little and the plant will lose the ability to transport nutrients, which are typically moved into the roots while in solution. These two researchers developed several formulas for mineral nutrient solutions, known as Hoagland solution. Modified Hoagland solutions are still in use.

One of the earliest successes of hydroponics occurred on Wake Island, a rocky atoll in the Pacific Ocean used as a refueling stop for Pan American Airlines. Hydroponics was used there in the 1930s to grow vegetables for the passengers. Hydroponics was a necessity on Wake Island because there was no soil, and it was prohibitively expensive to airlift in fresh vegetables. In the 1960s, Allen Cooper of England developed the Nutrient film technique. The Land Pavilion at Walt Disney World's EPCOT Center opened in 1982 and prominently features a variety of hydroponic techniques.

In recent decades, NASA has done extensive hydroponic research for its Controlled Ecological Life Support System (CELSS). Hydroponics research mimicking a Martian environment uses LED lighting to grow in a different color spectrum with much less heat. Ray Wheeler, a plant physiologist at Kennedy Space Center's Space Life Science Lab, believes that hydroponics will create advances within space travel, as a bioregenerative life support system. In 2007, Eurofresh Farms in Willcox, Arizona, sold more than 200 million pounds of hydroponically grown tomatoes. Eurofresh has 318 acres (1.3 km^2) under glass and represents about a third of the commercial hydroponic greenhouse area in the U.S. Eurofresh tomatoes were pesticide-free, grown in rockwool with top irrigation. Eurofresh declared bankruptcy, and the greenhouses were acquired by NatureSweet Ltd. in 2013. As of 2017, Canada had hundreds of acres of large-scale commercial hydroponic greenhouses, producing tomatoes, peppers and cucumbers. Due to technological advancements within the industry and numerous economic factors, the global hydroponics market is forecast to grow from $226.45 million USD in 2016 to $724.87 million USD by 2023.

METHODOLOGY

The total experiment was carried out in the Departmet of Botany, Kakatiya Government College, Hanamkonada, Warangal(U). We have implemented the following Methods to the objectives.

- **Selection of Plant Species for Hydroponics Culture:** Young and Healthy Onion Bulbils (Allium cepha) were selected for the Hydroponics culture.

- **Preparation of Hydroponics Nutrient Culture Medium:** Prepared Liquid nutrient medium in the suitable culture flasks for the culture for Onion Bulbils.

- **Culture of Crop plant in the Liquid Nutrient Medium:** Onion Bulbils were fixed longitudinally on the upper surface of the nutrient medium which was present in the specified culture flasks.
- **Incubation of Cultured Plants:** After the insertion of the plant material on the suitable nutrient medium, all culture flasks were kept in to the culture room with suitable temperature (25 ± 2^0C), Light intensity (2000-3000 lux.) and related humidity (60-70%).
- **Development of Cultured Plants:** After the incubation period (after one week), the onion bulbils were produced roots, also shoots and leaves.
- **Separation of Cultured plants:** Complete developed plants were separated from the cultures after 20 days.

DATA ANALYSIS

Hydroponics is the process of growing plants in media such as coco coir, rock wool, gravel, or liquid, with added nutrients but without soil.

Growing Systems

Hydroponic systems can either be liquid or aggregate. Liquid systems have no supporting medium for the plant roots; whereas, aggregate systems have a solid medium of support. Hydroponic systems are further categorized as open (once the nutrient solution is delivered to the plant roots, it is not reused) or closed (surplus solution is recovered, replenished,and recycled).

A. LIQUID HYDROPONIC SYSTEM: They are closed systems.

1. **Nutrient Film Technique (NFT):** Plants are placed in a polyethylene tube that has slits cut in the plastic for the roots to be inserted. Nutrient solution is pumped through this tube.

2. **Floating Hydroponics**: Plants are grown on a floating raft of expanded plastic.

3. **Aeroponics:** Plant roots remain suspended in an enclosed growing chamber, where they are sprayed with a mist of nutrient solution at short intervals, usually every few minutes.

B. AGGREGATE HYDROPONIC SYSTEM: This is an open system

1. **Rockwool Culture**: It is the most widely used medium in hydroponics. Rockwool is ground-up basalt rock that is heated then spun into threads making wool. It is very light and is often sold in cubes. Rockwool can hold water and retain sufficient air space (at least 18 percent) to promote
   optimum root growth.

2. **Sand Culture:**

   Closed Systems

1. **Gravel**
2. **NFT and Rockwool**: Plants are established on small rockwool slabs positioned in channels containing recycled nutrient solution.

These system are further categorized into:
1. passive systems
2. active systems
1. Passive systems use a wick and growing media with very high capillary action. This allows water to be drawn to the plant roots. The Wick System is by far the simplest type of hydroponic system.
2. Active systems work by actively passing a nutrient solution over your plants roots. Examples include:
The Water Culture System is the simplest of all active hydroponic systems. The platform that holds the plants is usually made of Styrofoam and floats directly on the nutrient solution. An air pump supplies air to the air stone that bubbles the nutrient solution and supplies oxygen to the roots of the plants.

The Ebb and Flow System works by temporarily flooding the grow tray with nutrient solution and then draining the solution back into the reservoir. This action is normally done with a submerged pump that is connected to a timer. The timer is set to come on several times a day, depending on the size and type of plants, temperature, humidity and the type of growing medium used.

Drip Systems are probably the most widely used type of hydroponic system in the world. A timer controls a submersed pump. The timer turns the pump on and nutrient solution is dripped onto the base of each plant by a small drip line.

NFT Systems have a constant flow of nutrient solution, so no timer is required for the submersible pump.

The Aeroponic System is probably the most high-tech type of hydroponic gardening. A timer controls the nutrient pump much like other types of hydroponic systems, except the aeroponic system needs a short cycle timer that runs the pump for a few seconds every couple of minutes

As global warming becomes a bigger issue for the average citizen, consumers and government leaders are always looking for better ways to cut down on carbon dioxide emissions and help the environment. Perhaps one of the greatest ways countries can cut back on harmful greenhouse gasses is through examining how they produce and distribute their food supply. Hydroponic growing has numerous possibilities to not only produce, larger, better tasting vegetables, but also help the environment. Here are the main ways that hydroponic growing may be the way to "go green" in the future.

Hydroponic Growing Uses Less Land – It is estimated that approximately 10 million hectares of arable land is lost every year for a variety of reasons. With farmers being increasingly pinched on the amount of land that can be used for traditional soil gardening, hydroponics may prove to be the solution. Because every element of this style of growing can be closely controlled, it can produce larger yields, making the same amount of vegetables in just 1/5th of the space.

Hydroponics Can Grow Vegetables Anywhere – This is important because it cuts down on the distance that food may have to travel to reach is destination. Whenever a vegetable is out of season in one part of the world, it is in season in another part. So these vegetables are often crated and shipped to those areas where they are not in season, where the scarcity can drive up prices. This means the transportation of the food requires a great deal of fossil fuel because of the flights. With hydroponics, you can grow virtually any vegetable in any season in any part of the world, so they can be grown closer to their sale point and use up less gas. They usually taste a lot better too, because the shorter distance that they have to travel means that they can be picked when they are ripe.

Hydroponics Uses Less Water – When watering a typical soil garden, much of the water used gets lost in the soil, which means a lot more water has to be used. In a hydroponic garden, the water is recycled. This puts a lot less stress on the increasingly strained water supply. Less Land Erosion – Traditional farming requires one to till the land, which can contribute to land erosion. Since hydroponics uses no soil, and therefore makes no significant changes to the land, this problem can be completely averted.

Fewer Pesticides – While pests are by no means completely absent in hydroponics systems, the closed, controlled environment can eliminate many of pesticides that are often necessary to keep bugs from destroying traditional crops. This means less poison on plants, in rivers, and more importantly, on the food we eat. All of these factors, plus the improved taste that can result from this style of growing has made hydroponics the choice of many large-scale greenhouses.

HYDROPONIC CULTURE OF ONION PLANT

Advantages:

1. It can be used in places where in-ground agriculture or gardening is not possible (for example, dry desert areas or cold climate regions).
2. More complete control of nutrient content, pH and growing environment.
3. Lower water and nutrient costs associated with water and nutrient recycling.
4. Faster growth due to more available oxygen in root area.
5. Elimination or reduction of soil related insects, fungi and bacteria.
6. Much higher crop yields.
7. No weeding or cultivation required.
8. Some crops, such as lettuce and strawberries, can be lifted from ground level to a much better height for planting, cultivation and harvesting.

9. Working conditions and hence lowers labor costs.
10. Crop rotation/fallowing is not necessary.
11. Transplant shock is reduced

Disadvantages:

1. Initial and operational costs are higher than soil culture.
2. Skill and knowledge are needed to operate properly.
3. Some diseases like Fusarium and Verticillium can spread quickly through the system. However, many varieties resistant to the above diseases have been bred.

Benifits

1. 1. Naturally Grown
2. 2. Pesticide Free
3. 3. Up to 40% faster growing rate
4. 4. 90% less water usage
5. 5. No Weeds or Pests
6. 6. Great Plant Quality and Taste
7. 7. Grow in Any Condition
8. 8. Smaller Growing Area.

CONCLUSION

"HYDROPONICS" is the growing of plants in a liquid nutrient solution with or without the use of artificial media. It has been recognized as a viable method of producing vegetables (tomatoes, lettuce, cucumbers and peppers) as well as ornamental crops such as herbs, roses and foliage plants. Due to the ban on methyl bromide in soil culture, the demand for hydroponically grown produce has rapidly increased in the last few years.

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