

Development of Protocol for Hydroponics Culture of an Economically Valuable Crop Plants

Dr. M. Rambabu¹, Dr. D. Ujjwala², Dr. T. Annie Sheron³

¹Associate Professor of Botany, Government Degree College(A), Narsampet, Warangal, Telangana, India

²Lecturer in Botany, Telangana Social Welfare Residential Degree College for Women, Warangal East , Warangal, Telangana, India

³Associate Professor of Botany, Government Degree College for Women, Begumpet, Hyderabad, Telangana, India

Abstract:

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. In the present investigation we have developed the protocol for economically important crop plants production through Hydroponics culture. Young and Healthy Onion Bulbils (*Allium cepha*) were selected for the Hydroponics culture. Prepared MS basal liquid nutrient medium and taken were in to the suitable culture flasks for the culture of Onion Bulbils. Blank or controls were also maintained along with the testing period. Onion Bulbils were fixed longitudinally on the upper surface of the MS nutrient medium. MS basal liquid nutrient mediated cultures responses was very well than compare with the controls.

Key Words: Hydroponics, MS Medium, *Allium cepha*, cultures

INTRODUCTION

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.

Hydroponics is the growing of plants in a liquid nutrient solution with or without the use of artificial media. Hydroponics is the practice of growing plants in a nutrient-rich water solution instead of soil (Gericke, William F., 1945). The term "hydroponics" originated from the Greek- "hydro," which means

water, and "ponos," which means labour (Nye, P. H. ,1981). Peat moss, charcoal, gravel, rock wool, perlite, coco peat, and coconut coir are only some of the inert media used in hydroponic systems to support plant roots (Walker, T. S. et.al., 2003 and Suryawanshi, Yogesh Chandrakant ,.2021). 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 modern hydroponic system was developed in the middle of the 20th century as a solution to boost food production in locations with limited resources and space (Horn, M.E. et.al., 2004). It is believed that the Hanging Gardens were created utilizing the first known application of hydroponic cultivation. Its promise to boost food production and sustainability, decrease water consumption, and raise crop yields has recently increased in popularity (Zhang, et.al., 2018).

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.

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.

METHODOLOGY:

In the present investigation we have developed the protocol for economically important crop plants production through Hydroponics culture. The total experiment was carried out in the department of Botany, Kakatiya Government College, Hanumakonada, Telangana State .We have implemented the following methods in the time of experiment.

Young and Healthy Onion Bulbils (*Allium cepha*) were selected for the Hydroponics culture. Prepared MS basal liquid nutrient medium and taken were in to the suitable culture flasks for the culture of Onion Bulbils. Blank or controls were also maintained along with the testing period. Onion Bulbils were fixed longitudinally on the upper surface of the MS nutrient medium which was present in the specified culture beakers. After the insertion of the plant material on the suitable nutrient medium, all culture beakers were kept in to the culture room (laboratory) with suitable room temperature. Nutrient media were supplied ones per a day to the testing cultures.

Table-1: Sowing the results of cultures in control and Nutrient Media

Plant Material	Incubation Period	Observations (growth in cms)			
		Control (without nutrients)		Nutrient Media*	
Onion bulbils		Root	Shoot	Root	Shoot
	1-week	1.5	0.3	1.7	0.5
	2 -weeks	3.0	2.5	3.5	3.0
	3-weeks	4.1	5.3	5.3	5.1
	4-weeks	4.9	6.5	6.0	8.5

*MS-Medium

RESULTS

Hydroponics cultures were showed various results in the nutrient and control flasks by week to week. After the incubation period (after one week), the onion bulbils were produced roots and leaves. Minimum root and shoot growth was observed in one week of cultures and maximum response was observe at four week of cultures(Table-1). Moderate response was identified in the two and three weeks of cultures. MS basal liquid nutrient mediated cultures responses was very well than compare with the controls. Complete plantlets were developed after 4-weeks(Table-1). These were separated from the culture flasks and shifted to the normal fields.

DISCUSSIONS

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 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. 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. 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. 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 abioregenerative life support system. In 2007, 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.

Specifically, in 2018, cities accommodated 55% of the global population (Sachs, Julius, 1887). According to another study, the percentage of the global population residing in urban areas was 30% in 1950 (Breazeale, J. F. However, projections indicate that by 2050, this figure is expected to increase to 68% (Hoagland, D.R, 1933).

Hydroponics allows for economical water consumption, typically using as much as 90% less water than conventional farming methods (Turner, Bambi, 2008). Hydroponics, with its carefully calibrated nutrient solutions, may produce far greater quantities of greens than conventional soil gardening (Gericke, William F.1937). Hydroponics also allows for greater crop output per unit area because of its vertical farming methodology, which makes the most efficient use of available space (Biography of WA Setchell,2018).

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