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TEST AND EVALUATION OF PROTOTYPE AEROPONIC SYSTEM FOR INDOOR VEGETABLE PLANT GROWTH

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Abstract **–** The availability of water and land is one of the significant factors to be investigated for sustainable agriculture all over the world. The present report discusses the aeroponic system and provides information on currently available soilless systems. In this study evaluate the growth of plants concerning their growing mediums. We investigate that coconut peeling is an efficient medium for plant growth. In coconut peeling the plant growth is 6.8cm which was more than the other growing medium. Aeroponic systems use less water than other soilless systems since water is circulated continuously. However, due to a lack of technical skills and sufficient literature, the aeroponic system is not fully implemented among local farmers, and only a few farmers have adopted the technique. Another purpose of this study was to investigate the effect of climatic conditions on plant growth and water consumption. On the first day of the experiment, the temperature is 32-degree celsius and the relative humidity is 35 percent and the average growth rate of plants in different growing media is 1.08 cm. At the end of the experiment, the temperature is 26.5degree celsius , relative humidity is 44 percent and the growth of plants is 5.70 cm. Hence with a decrease in temperature, the plant growth is increase and water consumption is decreased. As a result, the purpose of this research was to learn more about the development and maintenance activities involved in using an aeroponic system and growing plants with less use of water. These findings could help researchers, farmers, and individuals interested in using aeroponic technology learn more.

Keywords – Aeroponics, Humidity meter, LED lights, Irrigation interval, Soilless agriculture

I. INTRODUCTION

The world's population is predicted to increase by 3 billion people by 2050. To feed them, an additional 1010 hectares of cropland will be required. From the data it was estimated that the 80% of the world's arable land suitable for cultivation. Poor management has roughly 15% of this land unfit for cultivation, and climate change has claimed much more. Because people starting to transform their property into commercial and residential areas. The rapid development in urbanization and infrastructures may pose several issues for the agriculture industry[1]

Ending hunger and poverty while making agriculture and the food chain sustainable is important factor of current challenges. However, supplying clean and fresh food for future generations is one of our primary concerns, particularly given the world's rising population [2]. As the world's population grows, so will the demand for fresh food and clean water also increase. Climate change will have an impact on arable land. Therefore, the passing of time, interest in vertical and indoor farming is growing rapidly. Indoor agriculture uses less water than outdoor agriculture[3].

These advanced agricultural practices will be used in the future. Climate change will have a huge impact on plant growth in the future. The greenhouse effect with the climatic variations. Adopting this greenhouse approach enhance the crop productivity while lowering costs. Water scarcity is the most essential and critical issue for agricultural activity, as well as inflicting instability

on social issues. Modern approaches make advantage of minimal input and facilities to harvest several plants with maximum output. The soilless culture concept aims to provide an innovative solution for ensuring the environmental and economic sustainability of high-nutrient food supply. It is a highly recommended plant-growing approach for all countries with limited arable land, rapid environmental change, and growing food issues among indigenous populations. Several soilless procedures have been used to cultivate the plant in a controlled environment. It is mostly connected with the hydroponic and aeroponic methods of cultivation[4],[5]

Aeroponics is the practice of "growing in the air." In an aeroponic system, there is no need for a medium because the plant's roots are free to hang in an open root zone atmosphere. The supports that hold the plants at the top of the unit divide the vegetation zone. In a pressure holding tank, nutrients are mixed with water, purified, and then pumped into a reservoir basin where they are then sprayed erratically across the root system. The size of the water droplets must be sufficient to stop evaporation from the root mass. Any leftover solution is pumped back into the reservoir after being strained, filtered, and pushed down into the unit's base. [6],[7].

Current research works in automated aeroponic farming systems to evaluate the effect of different growing media on plant growth and also check the effect of climatic conditions on plants. Lake of research studies in soillesss agriculture in Pakistan, a present research study was planned to develop an aeroponic prototype plant with the auto controller to study the effect of growing media on plangrowth in aeroponic system
under various climatic conditions.

II. Materials and Method

A. EXPERIMENTAL SETUP AND DESIGN

Aeroponics is one of the soilless cultural techniques. The plant is growing in the air with the help of artificial support, rather than in soil or substrate culture. It is an air-water plant growing technique in which the plant's lowest portion, such as its roots, is suspended inside a growth chamber in complete darkness under regulated conditions. The design of this aeroponic system includes a timer that controls the irrigation interval, the submergible pump having a capacity of 180-230V, a plastic pipe of one inch for the following of water, and LED lights to meet the requirement of sunlight. It eliminates several environmental factors when compared to traditional agriculture. We utilize AutoCAD design software to create this aeroponic system. As a result, it is not reliant on large-scale land use, and it could be built anywhere, a structure that has lifted glob the al climate without taking into account present climate conditions such as rainy season and winter. According to, an atomization nozzle employs a small amount of water fertilizer solution to offer an optimal growing environment for plants. It is a modern agriculture research instrument that gives a researcher a variety of agricultural research chances as well as substantial findings by creating artificial growing circumstances[8].

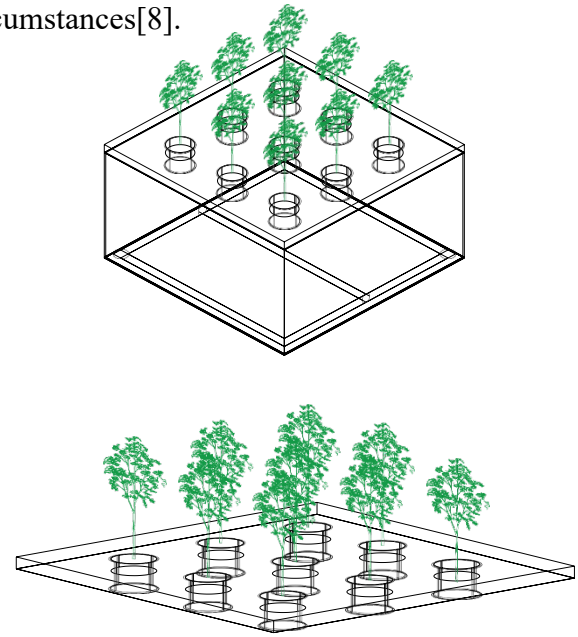

Fig. 1 3d Model design

Table. 1 Design specification

Parts	**Specification**
Submergible pump	180-230V
Plastic pipe	3 inches
Timer	Irrigation interval
Growth chamber	24*24*17.25 cm

B. AEROPONIC GROWING SYSTEM FOR INITIAL GROWTH OF GARLIC

Garlic is a widely consumed food crop all over the world. It is more cost-effective to grow it in an aeroponic system rather than in soil. The aeroponic approach gives an alternative to soilless growing in a controlled environment, such as a greenhouse. A higher-quality seed is used in this method. Hybrid seeds should be utilized to ease the problem of seed

deterioration. A high-pressure pump delivers water nutritional solution through perforated pipes at regular intervals in this arrangement. In this experiment,we use three types of growing medium to check the growth rate of the crop in this modern technique. In foam coconut pealing showed the higher growth of garlic plants. This medium is best for growing as compared to others. The water holding capacity of coconut peeling is greater than other mediums. In polyurethane foam, the growth rate is less than the cocount pealing. Its water holding capacity is higher than foam and other.

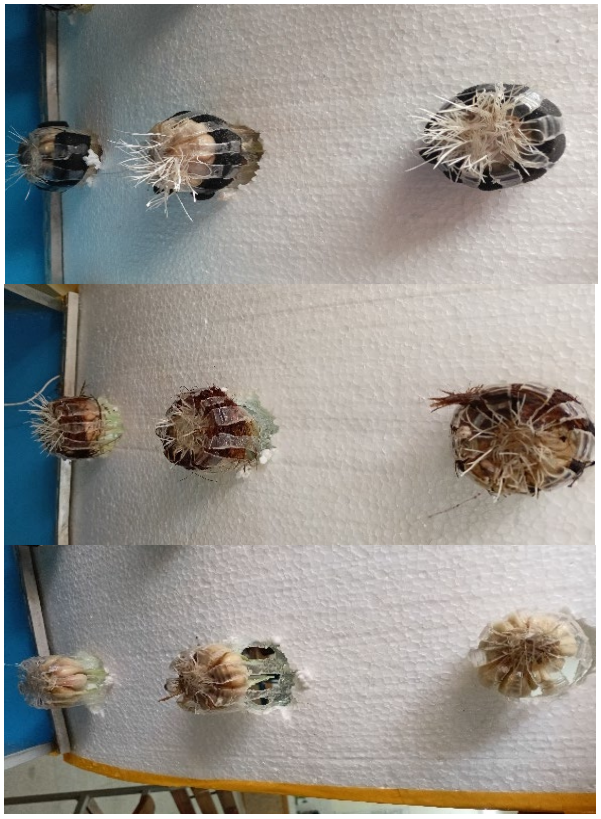

Fig. 2 Root growth in different growing media

The roots of the plants receive fertilizer spray mist in aeroponics systems. High, medium, and low-frequency atomization are the three types of atomization. The droplet size ranged from submicron to thousands of microns, and each was classified differently[9].

C. GROWTH CHAMBER

The Styrofoam layer, which comes in different sizes depending on where you are and is not readily available in all countries, is the most expensive component of the box structure. The box, however, must be changed to fit the size of the sheets. Larger sheets are more convenient and provide better results when distributing plants in boxes. Furthermore, the most common sheet sizes are 3*1.5m2 and 3*1.5m2. We use a steel box with dimensions of 24*24cm2 and a height of 17.25cm in this project. The roots of the plants must not be impacted by temperature changes in the greenhouse, thus the aeroponic boxes must be properly insulated, robust, and solid. The box can be framed with wood or metal. Wood, on the other hand, is preferred since it is inexpensive and readily available all over the world. Styrofoam is ideal, although compressed cardboard or compression sawdust can also work provided, that we give the appropriate moisture protection. All of these filter materials must be covered with opaque plastic, which is commercially available worldwide.

Fig. 3 Growth chamber

III. RESULTS

A. COMPARISON OF PLANT GROWTH IN DIFFERENT MEDIUM

Table. 2 Comparison of Plant Growth in Different Medium

Days	Coconut peeling(cm)	Polyurethane Foam(cm)	Without medium(cm)
1	1.25	1.1	0.9
2	2.55	2.05	1.84
3	3.9	3.04	2.81
4	5.3	4.34	3.79
5	6.8	5.54	4.78

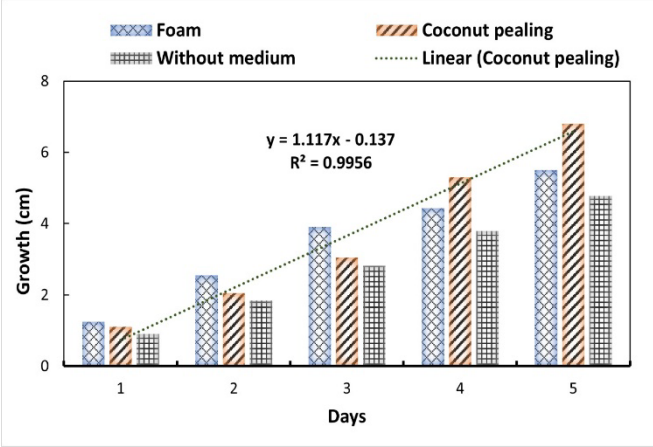

Fig.4 Comparison of Plant Growth in Different Medium

B. EFFECT OF TEMPERATURE ON PLANT GROWTH AND WATER CONSUMPTION

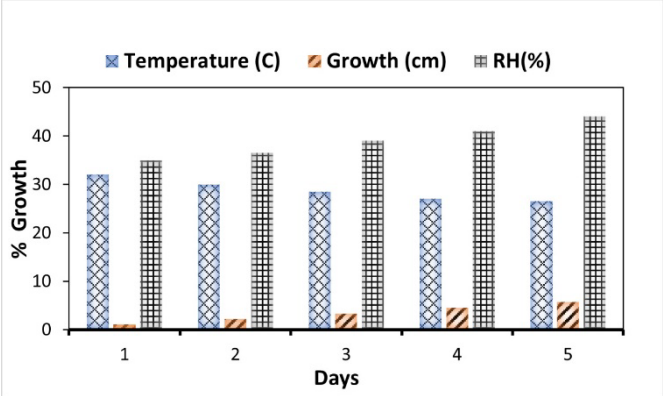

Fig. 5 Effect of temperature on plant growth

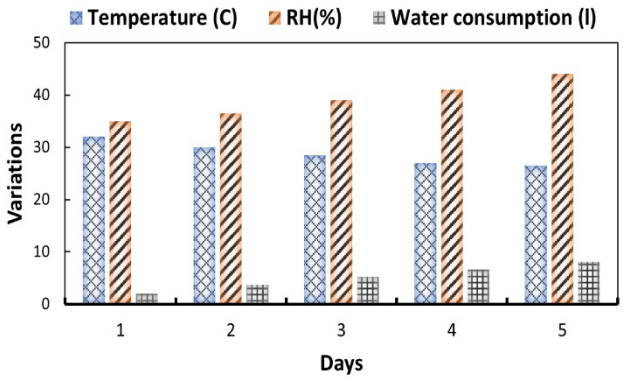

Fig. 6 Effect of climatic condition on water consumption

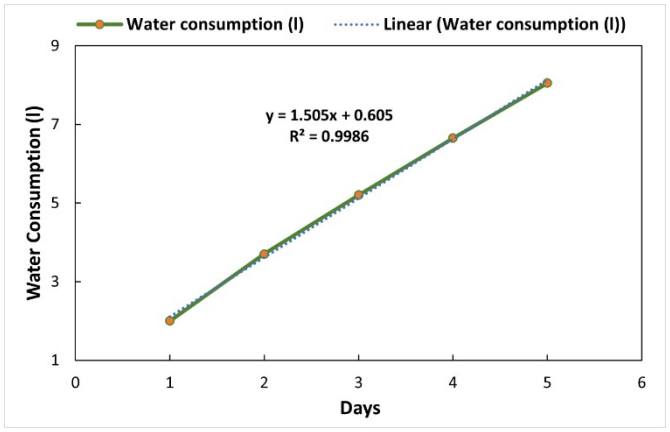

Fig. 7 Linear water consumption in an aeroponic system

IV. DISCUSSION

The goal of the study was to determine how the growing media in an aeroponic system affected plant growth. Over the duration of the study, the garlic plant's growth or length of its growing medium is depicted in Fig. 4. This figure shows that the coconut peeling medium is most efficient for plant growth. In coconut peeling the plant, height is 6.8 cm. On the other hand, the plant growth in polyurethane foam and without any medium is 5.54cm, 4.78cm. In fig. 5 we evaluate the effect of climatic conditions on plant growth. This figure it is shown that with the decrease in temperature the plant's growth increase. On the first day of experiment, the temperature is 32-degree celsius and the relative humidity is 35 percent and the average growth rate of plants in different growing media is 1.08 cm. At the end of the experiment, the temperature is 26.5 degrees celsius , relative humidity is 44 percent and the growth of plants is 5.70 cm.

V. CONCLUSION

It is said that growing plants in an aeroponics system is a secure and ecologically friendly approach to growing organic, healthy plants and commodities. Compared to other systems and methods including conventional production, hydroponics, and plant tissue culture, aeroponic seed multiplication has advantages. The processes of tissue culture and hydroponics require more time and labor. Water and energy are both conserved by aeroponic technology. Because an aeroponic system uses nutrient solution recirculation, it only consumes a small amount of water. Aeroponics will be used efficiently in many regions in the future. As a result, in desert places with a lot of non-cultivable lands, small areas, and a lot of people, aeroponics could be a viable food production option. Finding out how the

growing medium in an aeroponic system affects plant growth was another aim of the study. The plant's height in coconut peeling is 6.8 cm. However, the plant growth in polyurethane foam and the absence of any media is 5.54 cm and 4.78 cm, respectively. In light of these findings, coconut peeling is the most effective medium for growing plants in an aeroponic system. Another purpose of this study is to observe the effect of climatic conditions on plant growth. . On first day of the experiment the temperature is 32-degree celsius and the relative humidity is 35 percent and the average growth rate of plants in different growing media is 1.08 cm. At the end of the experiment, the temperature is 26.5 degrees celsius , relative humidity is 44 percent and the growth of plants is 5.70 cm. Results show that with the decrease in temperature the plant's growth is increased.

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