Hydroponics farming of tomato plant

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Abstract-
Vertical hydroponics is an innovative and sustainable farming technique that has gained significant attention in recent years. This abstract provides an overview of the concept of vertical hydroponics and highlights its potential as a solution for urban agriculture. Traditional agricultural practices face numerous challenges in urban environments, such as limited space, soil degradation, and water scarcity. Vertical hydroponics offers a viable alternative by maximizing land efficiency and reducing resource consumption. It involves growing plants in vertically stacked layers or structures, utilizing nutrient-rich water solutions instead of soil. Firstly, it enables year-round crop production in urban areas, overcoming seasonal limitations and reducing dependence on external food sources. Secondly, vertical hydroponic systems utilize significantly less water compared to conventional farming methods, as water is recirculated and reused within the closed system. This aspect is particularly crucial in regions where water resources are scarce. Furthermore, vertical hydroponics minimizes the use of pesticides and herbicides, as the controlled environment mitigates the risk of pests and diseases. This aspect contributes to the production of healthier and more environmentally friendly food options.

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INTRODUCTION

In an era of rapid urbanization, climate change, and an increasing global population, traditional agriculture faces unprecedented challenges. Hydroponic farming emerges as a sustainable solution, offering a revolutionary approach to growing crops without soil. This report delves into the world of hydroponics, exploring its principles, methods, environmental benefits, and the potential to shape the future of food production."New technologies are coming up every day in the world. As the world population is growing, the agriculture industry is also developing new techniques to grow food in lesser space and by saving water. The hydroponic growing system is a step towards this. Hydroponic System is a system of growing crops without soil, often called soilless farming. In the hydroponic system, the plant roots grow in a liquid nutrient solution or inside the moist inert materials like Rockwool and Vermiculite. The liquid nutrient solution is a mixture of essential plant nutrients in the water. The plant roots are suspended either in the static liquid solution or in a continuously flowing nutrient mixture. The hydroponic growing system requires continuous attention to the crops, unlike the traditional farming system At its most basic level, hydroponics is when plants are grown in a nutrient solution rather than soil. Instead of the roots growing down into dirt and gaining nutrients that way, in a hydroponic system, the roots grow into a liquid solution that is fortified with all the essential nutrients for healthy plants. While it is possible to grow plants hydroponically outside, the vast majority of hydroponic systems are used in greenhouses or other indoor spaces. There are many small, commercially available hydroponic systems that people can use to grow hydroponic plants in their homes.

Hydroponic gardening is space-efficient and takes less water than gardening in soil. Growing in water also means no weeds. With artificial lighting, you can grow hydroponically all year long, even in Minnesota. Although almost anything can be grown hydroponically, short-season crops or crops that do not produce fruit such as herbs and leafy greens are great choices for indoor production in the winter .In the summer, strawberries, tomatoes, cucumbers and peppers are all great choices. It's becoming more common for commercial growers of these crops to grow hydroponically instead of in soil.

LITURATURE SURVEY

1. *LED Lighting in Horticulture* by E. K. Yanagi and T. J. Blom (2018): This review provides a comprehensive overview of LED lighting technology, its applications in horticulture, and the benefits and challenges of its use. The authors discuss the different types of LEDs and their spectral characteristics, as well as the physiological effects of different light spectra on plant growth and development. They also review the latest research on LED lighting in hydroponic systems, and discuss the potential benefits of this technology for sustainable agriculture.

2. *Hydroponics: A Review of Its Advantages, Disadvantages, and Limitations* by J. Savvas (2019): This review provides a detailed overview of hydroponics technology, including its advantages, disadvantages, and limitations. The author discusses the different types of hydroponic systems, as well as the different nutrient solutions and growing media that can be used. He also reviews the latest research on hydroponics, and discusses the potential of this technology for improving food security and sustainability.

3. *LED Lighting in Vertical Farming Systems Enhances Bioactive Compounds and Productivity of Vegetables Crops* by A. Valdés-Gómez et al. (2022): This review focuses on the use of LED lighting in vertical farming systems to enhance the bioactive compounds and productivity of vegetable crops. The authors discuss the different factors that affect plant growth and development under LED lighting, including light intensity, spectrum, and photoperiod. They also review the latest research on the use of LED lighting to improve the nutritional quality and yield of vegetable crops grown in vertical farming systems.

4. *IoT-based Hydroponics: A Literature Review* by A. R. Yanes et al. (2020): This review focuses on the use of the Internet of Things (IoT) in hydroponic systems. The authors discuss the different IoT technologies that can be used to monitor and control hydroponic systems, as well as the benefits of using IoT to improve the efficiency and sustainability of hydroponics. They also review the latest research on IoT-based hydroponic systems, and discuss the future directions of this field.

Evaluation of IoT-Based Grow Light Automation on Hydroponic Plant Growth by Y. Prasetia (2021): This study evaluated the use of IoT-based grow light automation to improve the growth of hydroponic lettuce. The author developed an IoT-based system to control the intensity and duration of LED grow lights based on the light requirements of the lettuce plants. The results showed that the IoT-based grow light automation system significantly improved the growth of the lettuce plants, compared to plants grown under conventional LED grow light conditions.

AIM & OBJECTIVES

1. Maximize land efficiency in urban environments.
2. Reduce resource consumption, particularly water usage.
3. Enable year-round crop production, overcoming seasonal limitations.
4. Decrease dependence on external food sources.
5. Minimize the use of pesticides and herbicides.
6. Create healthier and more environmentally friendly food options.
7. Mitigate soil degradation concerns.
8. Address water scarcity challenges.
9. Utilize nutrient-rich water solutions instead of soil.
10. Provide a sustainable farming technique for urban agriculture..

MOTIVATION

Vertical hydroponics represents a compelling solution to the multifaceted challenges faced by traditional agricultural practices in urban settings. With cities becoming increasingly crowded and resources dwindling, the need for innovative and sustainable farming techniques has never been more urgent. The motivation behind embracing vertical hydroponics lies in its ability to revolutionize urban agriculture by maximizing the efficient use of limited space and resources. By growing plants in vertically stacked layers and utilizing nutrient-rich water solutions instead of soil, this method not only enables year-round crop production but also reduces dependence on external food sources. Furthermore, its significantly lower water consumption compared to conventional farming methods addresses water scarcity concerns, making it especially relevant in regions facing this challenge. Moreover, the minimized use of pesticides and herbicides in controlled environments contributes to producing healthier and more environmentally friendly food options. Overall, the motivation for implementing vertical hydroponics stems from its potential to create a sustainable and resilient food production system that can thrive in the face of urbanization and environmental pressures.

COMPARISON BETWEEN HYDROPHONIC FARMING AND TRADITIONAL FARMING

CHARATERISTIC	HYDROPHONIC	TRADITIONAL
Growing medium	Nutrient-rich solution	Soil
Water usage	90-98% less water usage	Requires more water
Land usage	99% less land usage	Requires more land
Yields	20-50% higher yields	Lower yield
Growing season	Can grow crops year-round	Limited to growing seasons
Climate control	Can be grown indoors or outdoors	Can only be grown outdoors
Pests and diseases	Less susceptible to pests and diseases	More susceptible to pests and diseases |

APPLICATION:

1. Urban Agriculture: Vertical hydroponics can be applied in urban areas to grow fresh produce locally, reducing the need for long-distance transportation and providing city dwellers with access to fresh, nutritious food.

2. Rooftop Gardens: Vertical hydroponic systems are well-suited for rooftop gardens in urban environments, where space is limited but sunlight is abundant. This application maximizes the use of available space while minimizing the environmental footprint.

3. Indoor Farming: Vertical hydroponics can be implemented indoors, such as in warehouses or shipping

containers, allowing for controlled environments where factors like temperature, humidity, and light can be optimized for plant growth.

4. Educational Facilities: Vertical hydroponics is increasingly being used in schools and educational institutions as a hands-on learning tool to teach students about sustainable agriculture, biology, and environmental science.

5. Restaurants and Hotels: Some restaurants and hotels incorporate vertical hydroponic systems into their establishments to grow herbs, vegetables, and microgreens on-site, providing fresh ingredients for their dishes while enhancing their sustainability credentials.

6. Residential Gardening: Homeowners and urban residents can install smaller-scale vertical hydroponic systems in their apartments or balconies to grow their own fresh produce, even in limited space environments.

7. Research and Development: Vertical hydroponics is also utilized in research institutions and agricultural laboratories to study plant biology, optimize growing conditions, and develop new varieties of crops adapted to this innovative farming technique.

8. Community Gardens: Vertical hydroponic systems can be implemented in community gardens or shared spaces, allowing residents to collectively grow food and strengthen community ties while promoting sustainability.

9. Food Banks and Community Centers: Vertical hydroponics can support food security initiatives by providing fresh, locally grown produce to food banks, community centers, and other organizations serving vulnerable populations.

10. Commercial Farming: Large-scale vertical hydroponic farms are emerging as a commercial agriculture option, especially in areas where land is scarce or unsuitable for traditional farming, offering a more sustainable and efficient way to produce food for markets.

Safety Requirements:

The system must employ robust data security measures to protect sensitive user data, including farm-specific information and soil analysis results. Data should be encrypted during transmission and storage to prevent unauthorized access or data breaches

Security Requirements

- High Availability: The system should have high availability to ensure continuous surveillance and incident detection.
- Fault Tolerance: It must be resilient to hardware failures or software errors.

Security Requirements

- Data Encryption: Implement strong encryption to secure video feeds, incident data, and communication between system components.
- Access Control: Enforce strict access controls to prevent unauthorized access to the system.
- Authentication and Authorization: Ensure that only authorized users and systems can configure and interact with the surveillance system.

RESULTS

CONCLUSION

The aim of this project was to study different types of hydroponic systems and understand iit's concept in depth. Thereafter, focusing on the different parameters that affects the growth of the hydroponic plants. The parameters which were identified are the pH, electrical conductivity, temperature, relative humidity, nutrients, light intensity. Several research papers were studied before on the earlier mentioned parameters before staring the experiment. Fenugreek plant was chosen as it's seeds are readily available in the market and it is one of the most versatile plant. The proposed system used LED strips for the purpose of providing light to the plant for photosynthesis plant. The LEDs selected have colours – red, blue, white and green. These light colours helped the plant receive all the different types of wavelength required for it's healthy growth. For complete growth of the plant estimated time is around 30- 40 days including the buffer days. The current growth of the plant is at an optimum level after 2 weeks into plantation. Since the system is an indoor system, proper setup had to be prepared for the experimentation. The setup consists of a pump, temperature sensor, PVC pipes NFT Channels, Water storage tank nutrients, and LED strips. The completion of setup took about a week of time as proper fittings and cuttings had to be done based on the measurements of the cube. It was observed that the growth of the fenugreek plant in our hydroponic system was greater than that of soil based technique and the plants were healthy as expected. conclusion, vertical hydroponics presents an innovative and sustainable approach to urban agriculture. By leveraging vertical space, conserving water resources, and creating controlled growing environments, this technique holds immense potential to revolutionize food production in cities. As urbanization continues to accelerate, embracing vertical hydroponics can contribute to building resilient, self-sufficient, and environmentally conscious communities

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