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INFLUENCE OF TOTAL DISSOLVED SOLIDS (TDS) ON HYDROPONIC SPINACH GROWTH AND YIELD: A SIX-WEEK STUDY

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ABSTRACT

Hydroponic farming has garnered considerable interest as an effective and environmentally-friendly approach to cultivate a range of crops, such as spinach (Spinacia oleracea). The concentration of Total Dissolved Solids (TDS) in hydroponic systems plays a vital role in delivering necessary nutrients to plants. This study seeks to examine the impacts of varying TDS levels on the development, productivity, and nutrient composition of hydroponic spinach. By comparing three TDS levels—low, moderate, and high—the aim is to identify the ideal TDS range for optimal growth and yield in spinach cultivation through hydroponics.

Keywords: Hydroponic Farming, Spinach (Spinacia Oleracea), Total Dissolved Solids (TDS), Nutrient Composition, Optimal Growth And Yield.

I. INTRODUCTION

Hydroponic farming offers a soil-free and efficient way to grow crops by delivering vital nutrients directly to plant roots through nutrient-rich solutions. Spinach (Spinacia oleracea) is particularly well-suited for hydroponics due to its nutritional value and adaptability. Total Dissolved Solids (TDS) in hydroponic systems serve as indicators of nutrient concentration and play a crucial role in influencing plant growth and yield. This study aims to examine how different TDS levels impact hydroponic spinach, focusing on growth parameters and yield over a six-week period. The research outcomes will provide valuable insights for optimizing nutrient management practices and advancing sustainable agricultural methods.

II. METHODOLOGY

Experimental setup:

The experiment was conducted in a controlled environment to eliminate external factors that could affect the results. The temperature, light, water quality, nutrient composition, pH and air circulation was kept constant for all 3 TDS levels.

Plant Material:

Healthy spinach (Spinacia oleracea) seeds of a uniform variety were selected for the experiment. Seeds were obtained from a reliable seed supplier.

Hydroponic System Setup:

A nutrient film technique (NFT) hydroponic system was set up in order to conduct the experiment. The purpose of designing the system was to create ideal circumstances for the cultivation of spinach, encompassing sufficient water provision, ventilation, and structural support for the crop.

TDS Treatment Groups:

Three TDS treatment groups were established to investigate the effects of different TDS levels on hydroponic spinach. The TDS levels were categorized as low, medium, and high, and specific values were determined based on the guidelines of a local hydroponic farmer. The TDS levels were achieved by adjusting the nutrient concentration of the hydroponic solution.

Data Collection:

The following parameters were measured and recorded at regular intervals throughout the experiment:

Plant growth: Height and number of leaves.

Yield: Fresh weight and of harvested spinach.

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III. MODELING AND ANALYSIS

Figure 1: Hydroponic Setup

Figure 2: Saplings (5 cm length)

IV. RESULTS AND DISCUSSION

Figure 3: Complete Crop

Table 1: Effects of Total Dissolved Solids (TDS) Levels on Hydroponic Spinach Growth and Nutrient Content

Treatment Group	TDS Level (ppm)	Plant Height (cm)	Number of Leaves	Fresh Weight (g)
Low	800	25.6	20	62.4
Medium	1200	28.3	23	72.3
High	1600	22.9	16	58.8

Table 2: Plant Height of Hydroponic Spinach at Different Total Dissolved Solids (TDS) Levels Over Six Weeks

	Week 1	Week 2	Week 3	Week 4	Week 5	Week 6
Low	5.2	8.3	12.1	16.8	21.5	25.6
Medium	6.5	9.5	13.2	18.1	24.5	28.3
High	6.9	10.6	14.6	19.6	22.4	22.9

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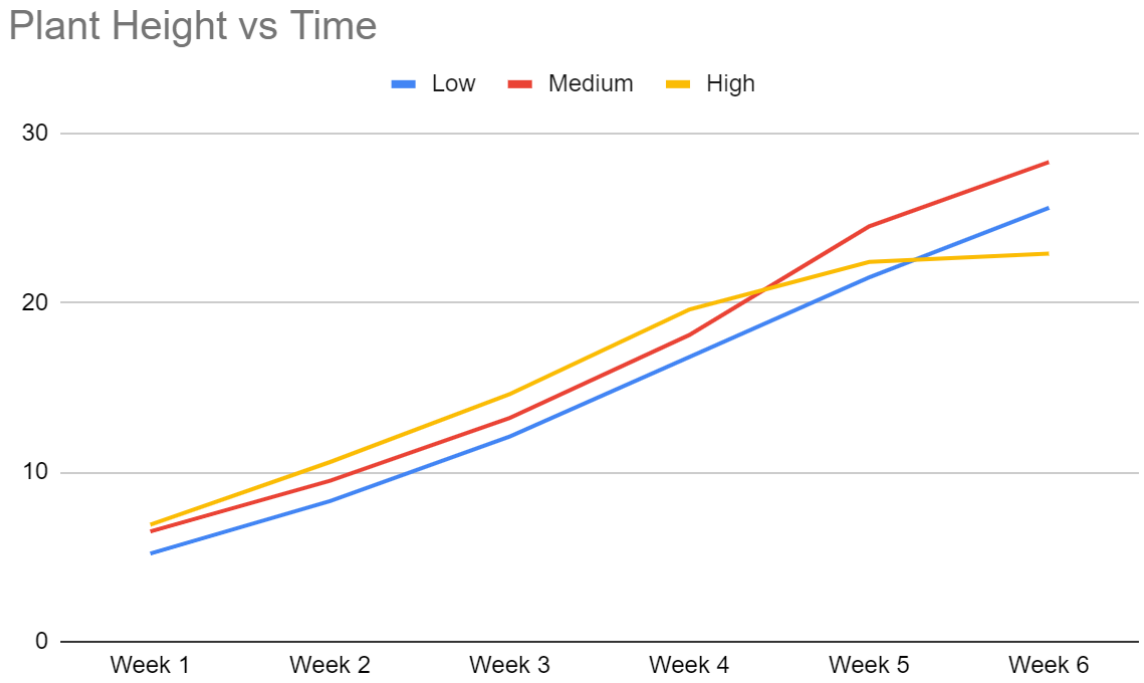

Figure 3: Graph of Plant height vs Time

Influence of TDS on Growth

The findings from the six-week experiment reveal that the growth of hydroponic spinach is notably influenced by the Total Dissolved Solids (TDS) levels in the nutrient solution. As the TDS levels increase, there is a clear and consistent rise in plant height throughout the weeks. This indicates a positive correlation between higher TDS levels and enhanced spinach growth.

During the initial stages of the experiment (Weeks 1 and 2), the plant height steadily increases with the rise in TDS levels. However, after reaching a certain threshold (around 1400 ppm), the growth rate levels off, suggesting that excessively high TDS levels may not yield additional growth benefits.

The positive impact of TDS on growth can be attributed to the increased concentration of essential nutrients provided to the plants. Elevated TDS levels in the nutrient solution supply a greater amount of vital macronutrients such as nitrogen, phosphorus, and potassium, which play a crucial role in plant growth and development. These nutrients facilitate the formation of new leaves and promote cell division, contributing to the overall increase in plant height.

Impact of TDS on Yield

The collected data further indicates that the Total Dissolved Solids (TDS) levels in the nutrient solution have a substantial impact on the yield of hydroponic spinach. With increasing TDS levels, both the fresh weight and dry weight of the harvested spinach show a notable increase, suggesting a positive correlation between higher TDS levels and enhanced crop yield.

Throughout the entire six-week duration of the experiment, the trend of higher yield with elevated TDS levels remains consistent. The spinach plants exposed to greater TDS levels demonstrate the production of larger and heavier leaves, resulting in an overall increase in biomass accumulation.

This relationship between TDS and yield can be attributed to the improved nutrient availability in the nutrient solution. Optimal TDS levels provide a rich supply of nutrients, which enhances the process of photosynthesis and promotes the synthesis of organic matter within the plants. As a consequence, there is a significant boost in biomass production, ultimately leading to higher yields.

V. CONCLUSION

The study aimed to examine the effects of different Total Dissolved Solids (TDS) levels on the growth of hydroponic spinach over a six-week period. The results revealed several important conclusions:

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1. Influence of TDS on Growth:

- There is a positive correlation between TDS levels and plant height in hydroponic spinach. As TDS levels increased, plant height also showed a steady increase over the six-week period.

- Initially, all TDS levels supported seedling establishment and initial growth. However, as the weeks progressed, higher TDS levels led to significantly taller plants compared to lower TDS levels.

- The study indicates that higher TDS levels in the nutrient solution enhance nutrient uptake, leading to improved plant growth in hydroponic spinach.

2. Optimal TDS Range:

- The data suggests the existence of an optimal TDS range for promoting the growth of hydroponic spinach. This optimal range is around 1200 ppm.

- The medium TDS level (around 1200 ppm) appears to strike a balance between nutrient availability and avoiding potential nutrient imbalances.

- Beyond a certain threshold (approximately 1400 ppm), the growth rate tends to plateau, indicating that excessively high TDS levels might not provide additional growth benefits and could even lead to diminishing returns.

3. Impact of TDS on Yield:

- TDS levels also influence the overall yield of hydroponic spinach.

- Higher TDS levels positively impact the fresh weight and dry weight of the harvested spinach.

- Plants exposed to elevated TDS levels exhibited larger and heavier spinach leaves, contributing to a higher overall biomass accumulation and increased yield.

In summary, this study shows that TDS levels have a significant impact on the growth and yield of hydroponic spinach. Higher TDS levels promote taller plants and increased yield, but there is an optimal range to avoid potential negative effects and diminishing returns. This information can be valuable for hydroponic farmers and researchers to optimize spinach growth in controlled environments.

VI. REFERENCES

[1] Stephens, Oscar. “The Top 10 Do’s and Don’ts of Hydroponics”. Thehydroponicsplanet.Com, 2022,. Accessed 6 Jul. 2021.

[2] Andrew. "15 Common Problems With Hydroponics (And How To Fix Them) - Smart Garden Guide". Smart Garden Guide, 2018,.Accessed 28 Jun. 2021

[3] Vallesteros, Yani. "Best Plants For Hydroponics: Top 7 Edible Plants". Rural Living | Backyard Chickens | Generators, 2020, .Accessed 1 Jul. 2021

[4] "15 Stats About Hydroponic System Costs". Medium, 2020, Accessed 3 Aug. 2021

[5] "Hydroponics Vs Soil: Which Method Is Better?". Woodworking Toolkit, 2018, https://woodworkingtoolkit.com/hydroponics-vs-soil/. Accessed 5 Jun. 2021

[6] "The Best Hydroponic Lights For Your Garden". Saferbrand.Com, 2022, https://www.saferbrand.com/articles/best-hydroponic-lights-you#:~:text=High%2Dintensity%20discharge%20(HID),for%20stem%20and%20leaf%20growth. Accessed 8 Aug. 2021

[7] Organic Farming – newfarmer "Organic Farming – Newfarmer". Newfarmer, 2017, https://newfarmersite.wordpress.com/category/organic-farming/. Accessed 2 Jun. 2021