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# Performance of mint crop (*Lamiaceae*) in nft hydroponics system

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**Abstract**
Hydroponics particularly the Nutrient Film Technique (NFT), offers advantages like reduced water usage, faster plant growth, and cleaner produce. Mint (Mentha spp.) is a high-demand aromatic herb widely used in culinary, medicinal, and cosmetic industries. However, consistent quality and supply are often constrained by space and seasonal factors. This study focuses on developing and evaluating a vertical wall-mounted NFT hydroponic system specifically for mint cultivation. The vertical setup addresses urban space limitations while maintaining an efficient nutrient delivery system. Three different NPK nutrient combinations were tested (T1: 40:65:40, T2: 50:75:50, and T3: 60:85:60) to identify their influence on vegetative and root growth. By analysing key parameters such as plant height, number of leaves, branching, and root length, the experiment aimed to optimize nutrient management in a controlled environment. the treatments, VT1 (40:65:40 NPK) exhibited superior results in terms of plant height, number of leaves, and branching, while VT3 (60:85:60 NPK) showed enhanced root development. ANOVA results confirmed that the variations in growth parameters across treatments were statistically significant ($P < 0.05$).

**Keywords:** Mint cultivation, NFT hydroponics, vertical farming, nutrient management, plant growth parameters

## Introduction

In the world day by day papulation will increases expected by end 2050 it will two to three billion people on the earth. Soilless farming is a potential answer to these problems. Two techniques for growing plants without soil are hydroponics and aeroponics (Agrawal, R.K *et.al.*2020) [1]. Hydroponic and aeroponic crop cultures have been used by many farms all over the world for agricultural production and research. With its considerable advancements over the last half-century, the technology might currently be the most intensive crop production method employed in the contemporary agriculture industry (Agustina, *et al.*2024) [2].

The NFT system, pioneered by Allan Cooper in England during the 1960s, revolutionizes hydroponic farming. It operates by circulating dissolved nutrients through plant roots via shallow water streams in waterproof channels. This unique approach ensures optimal air exposure for root mats, promoting efficient nutrient absorption. Studies attest to NFT systems' superior water and nutrient utilization, outperforming traditional soil-based methods and yielding higher crop yields. Ongoing advancements, including the integration of auxiliary mediums and expanded procedures, continue to enhance NFT technology. Notably, lettuce stands out as a primary crop cultivated using the Nutrient Film Technique (Vedantam, S.K. *et al.*2025) [18].

The Nutrient Film Technique (NFT) is one of the most efficient and widely used hydroponic systems for growing leafy crops and herbs. In an NFT system, a thin film of nutrient-rich water continuously flows through slightly. sloped channels, allowing plant roots to absorb nutrients directly while being partially exposed to air for adequate oxygenation. Unlike traditional soil-based agriculture, NFT eliminates the need for soil, instead using inert support structures like net cups or foam inserts to hold the plants. This results in cleaner growth, reduced pest infestations, and faster plant development. NFT systems are especially favored for their simplicity, low water usage, and reusability of nutrient solutions, making them highly sustainable and cost-effective over time. The wall-mounted configuration of the NFT system takes this innovation a step further. By aligning channels vertically along a wall or support structure, this setup maximizes space usage an essential feature for urban farming, indoor gardens, schools, and small balconies. These systems are not only compact and visually appealing but also capable of supporting a wide range of leafy greens, herbs, and small fruiting plants. In such systems, multiple NFT channels are arranged vertically against a wall or structure, enabling the cultivation of many plants in a relatively compact footprint. This design is particularly beneficial for urban farming and indoor gardening where horizontal space is limited. The vertical layout not only increases yield per square foot but also enhances accessibility for maintenance and harvesting. These systems can be installed on balconies, rooftops, or even indoor walls, and can be integrated with artificial lighting and controlled climate environments to support year-round cultivation. Additionally, the elevation reduces exposure to soil-borne diseases and ground-dwelling pests, promoting healthier crop growth (Griffith, M.A.C *et al.*2023) [3].

The main objective of this study was to conduct a comparative analysis be tween crops grown using NFT systems and DWC systems using GREENBOX technology. We monitored the environmental conditions and measured the biomass and productivity of crops grown in each technique to determine if there were any significant differences. Descriptive statistics were reported, and statis tical analysis using a paired t-test were used to understand the differences in biomass parameters between DWC-grown and NFT-grown lettuce crops. The results from these experiments will inform us about the technical feasibility of utilizing different soilless cultivation methods using GREENBOX technology, which may be considered for future design iterations (Tripathi, A. K. 2025) [17].

**Materials and Methods**

**1. Location of study**

The study was conducted in department of agricultural engineering at Aditya university, Andhra Pradesh. The experiment was carried out during 2025 at the Department of Agricultural engineering. Aditya University which is located at a latitude of 17.0894° N and 82.0668° E.

**2. Development of NFT Vertical Wall Mounted Hydroponic System**

The development of a Nutrient Film Technique (NFT) vertical wall mounted hydroponic system involves designing a space-efficient, soil-free cultivation setup that utilizes a continuous flow of nutrient-rich water along slightly inclined channels where plant roots are suspended. This system is optimized for urban agriculture, allowing crops to grow vertically on walls, making it ideal for limited spaces such as balconies or indoor gardens. Key components include PVC channels or trays, a water reservoir, a submersible pump for nutrient circulation, and a supportive wall-mount structure. Emphasis is placed on maximizing light exposure, minimizing water usage, and ensuring ease of maintenance. The innovation lies in its modular design, scalability, and potential integration with automated systems for nutrient delivery and environmental monitoring. Different Components Used the following components are used during the project: net cups, submersible pump, GI pipe, CPVC pipes, pH meter, TDS meter, NFT channel, End cups, Reservoir, LECA balls, cocopeat, and nutrient solutions.

Net Cups In hydroponics, net pots, also called net cups, are miniature plastic pots with a mesh-like structure that allow roots to grow freely and access nutrients and oxygen, promoting healthy plant development. They are used in hydroponics to hold, contain, and anchor a plant's roots to your hydroponic system. they are round or square in appearance with a distinct net shape to them, which allows water and air to flow through your plant's roots simultaneously (Saikrishna V. *et al*.2024) [20].

**2.1 Submersible Pump**

Submersible pumps are designed to operate while submerged directly into the nutrient reservoir. They are compact and space-efficient, making them an excellent choice for smaller hydroponic setups.

**2.2 NFT Channels Nutrient film technique (NFT)**

Hydroponic technique where in a very shallow stream of water containing all the dissolved nutrients required for plant growth is re-circulated past the bare roots of plants in a watertight gully, also known as channels. Hydroponics NFT systems use a precise delivery system to provide water and nutrients directly to the plant roots, reducing the water required to maintain healthy plant growth. This targeted delivery system ensures water is used only where needed, reducing overall water consumption (Singh, P.K. *et al*.2025) [15]

**2.3 End Cap**

In hydroponic systems, end caps, especially for Nutrient Film Technique (NFT) channels, are used to create watertight seals and manage water flow, with options for closed ends and spouted outlets for easy assembly and water recirculation.


**2.4 Reservoir**

In hydroponics, a reservoir is a container that holds and circulates the nutrient solution, providing plants with water and essential nutrients, and often houses pumps and air stones. They normally utilize a lid or cover to prevent contaminants from getting into your nutrient solution. A plastic container is adequate. Some people use heavy duty plastic garbage containers, and plastic livestock watering troughs can be used for larger NFT systems.

**2.5 Nutrient Solutions**

In hydroponics, plants obtain nutrients from a nutrient solution instead of soil, requiring a balanced mix of macronutrients (nitrogen, phosphorus, potassium) and micronutrients (iron, calcium, magnesium, etc.) for optimal growth.

**3. Production of mint crop in NFT system**

Mint or Mentha belongs to lamiaceae family, which contains around 15 20 plant species including Peppermint and spearmint. The mint leaves can be used fresh or dried in many dishes. It is a popular ingredient in several foods and beverages, ranging from teas to sauces, salads and desserts.

**3.1 pH and EC maintenance**

Nutrient solutions in hydroponic systems supply all the vital elements necessary for plant growth. The pH level of these solutions influences the availability of these essential nutrients. Variations in pH can lead to nutrient deficiencies, causing plants to exhibit deficiency symptoms. According to Wang *et al*. 2017, nutrient absorption can alter the pH, making it more acidic or alkaline. To keep the pH stable, it was calibrated weekly. If the pH decreased, 12.5 g of sodium hydroxide or potassium hydroxide was added per liter of water to raise it. Conversely, to lower the pH in the fertilizer tank, 6.25 g of phosphoric or sulfuric acid was added per liter of water. Careful attention was given to ensure the pH and EC were maintained at optimal levels.

## Result and Discussion

The objective of the study is to examine the effect of NFT hydroponic systems and nutrient combinations on the growth parameters of mint. Terminal cuttings of 15 cm length were prepared and planted in portrays filled with coir pith. After the fourth true leaf stage, the cuttings were transplanted along with the ball of earth into modified NFT structures. The treatments are as follows Factors (Venkatesh, J.D.2024) [19].

T1= 40:65:40, T2= 50:75:50 and T3= 60:85:60

V = vertical hydroponics system

### 1. Nutrient combination effect on lant height

The comparative analysis of plant height under different nutrient treatments in a vertical NFT hydroponic system showed that T2 (50:75:50 NPK) resulted in the tallest mint plants, indicating an optimal nutrient balance for vertical shoot development. T1 (40:65:40 NPK) followed closely, while T3 (60:85:60 NPK) exhibited reduced plant height, suggesting possible nutrient stress or imbalance due to higher concentrations Shanmugabhavatharani.*et al*.2021) [14]. These results imply that a moderate NPK level (T2) supports vigorous vertical growth, making it suitable for enhancing plant height in space-limited urban hydroponic farming systems (Tejaswini, V *et al*.2025) [16]. The details analysis shown (Table.1. and Fig.1). ANOVA results for Nutrient Combinations in NFT Hydroponics on growth Table.2.

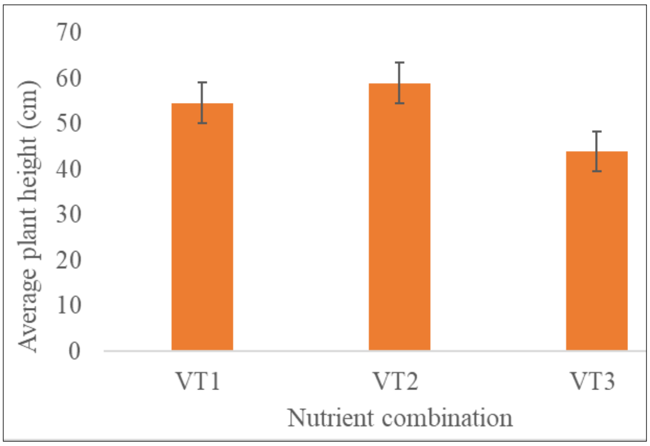


**Fig 1:** Nutrient combination effect on plant height

### 2. Nutrient combination effect on number of branches

The effect of different NPK nutrient combinations on the number of branches in mint grown under a vertical NFT hydroponic system revealed that T1 (40:65:40) resulted in the highest branching (18.67), followed by T2 (50:75:50) with moderate branching (16.33). T3 (60:85:60) recorded the least number of branches (10.67), suggesting that an excessive nutrient supply may have negatively influenced lateral shoot development. These findings emphasize that balanced nutrient supply (as in T1) promotes better morphological branching, which is essential for increasing overall leaf area and biomass in hydroponic mint cultivation (Shanmugabhavatharani.*et al*.2021) [14]. The details analysis shown (Table.1 and Fig.2). ANOVA results for Nutrient Combinations in NFT Hydroponics on growth Table.2.

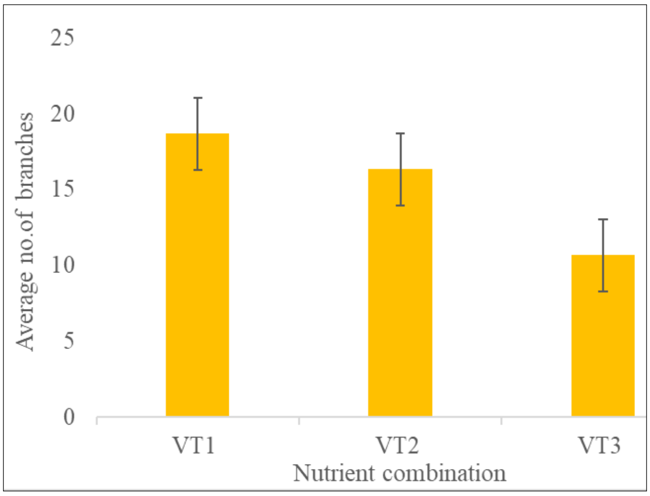


**Fig 2**: Nutrient combination effect on branches

### 3. Nutrient combination effect on no of leaves

The evaluation of different NPK combinations under a vertical NFT hydroponic system revealed that the T1 treatment (40:65:40 NPK) recorded the highest average number of leaves (167.33)**,** followed by T2 (50:75:50) with 154.33 leaves. T3 (60:85:60) produced the lowest leaf count (88.33), indicating that excessive nutrient concentration may negatively affect leaf initiation or overall vegetative growth. The results suggest that moderate nutrient levels (T1) are more favorable for enhancing foliage production in mint under controlled hydroponic conditions, which is essential for maximizing biomass and marketable yield (Shanmugabhavatharani.*et al*.2021) [14]. The details analysis shown (Table.1 and Fig.3).

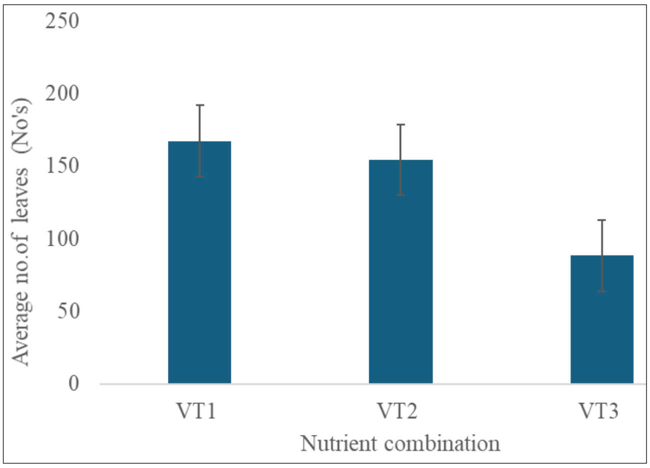


**Fig 3:** Nutrient combination effect on leaves

### 4. Nutrient combination effect on root length

The data on root length under different NPK nutrient treatments in a vertical NFT hydroponic system revealed that T3 (60:85:60) produced the longest roots (22.67 cm), followed closely by T1 (40:65:40) with an average root length of 20.33 cm. In contrast, T2 (50:75:50) showed the shortest root development (13.33 cm). These findings indicate that higher nutrient concentration (T3) may enhance root elongation, possibly due to increased nutrient absorption or osmotic adjustment. However, excessive nutrients can compromise shoot growth, as observed in other parameters. Therefore, T1 is identified as a more balanced treatment for optimal root and shoot development in mint cultivation under hydroponic systems (Shanmugabhavatharani.*et al*.2021) [14]. The details analysis shown (Table.1 and Fig.4).

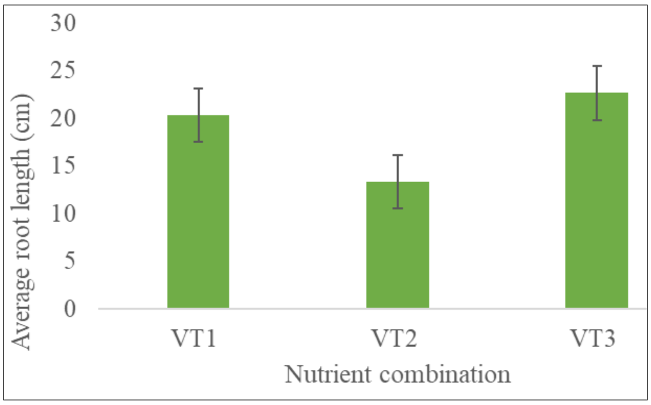


**Fig 4:** Nutrient combination effect on root length

**Table 1**: Effect of NFT systems and three different nutrient solutions on mint crop height, number of leaves, number of branches and root length

| Parameters | Nutrient Combination | | |
|---|---|---|---|
| | VT1 (T1) | VT2 (T2) | VT3 (T3) |
| Plant Height (cm) | 54.67 cm | 59.0 cm | 44.0 cm |
| No. of Leaves (No's) | 167.33 | 154.33 | 88.33 |
| No. of Branches (No's) | 18.67 | 16.33 | 10.67 |
| Root Length (cm) | 20.33 | 13.33 | 22.67 |

**Table 2:** ANOVA Results for Nutrient Combinations in NFT Hydroponics on growth

| Parameter | F-Value | P-Value |
|---|---|---|
| Plant Height | 32.84 | 0.0006 |
| No. of Leaves | 520.94 | 0.0000 |
| No. of Branches | 21.76 | 0.0018 |
| Root Length | 19.30 | 0.0024 |

**(**P-values are less than 0.05, the differences between treatments (VT1, VT2, VT3) are statistically significant for all growth parameters)

## Conclusion

The study on the development and evaluation of a vertical NFT hydroponic system using different NPK nutrient combinations revealed significant differences in mint plant performance. Among the treatments, VT1 (40:65:40 NPK) exhibited superior results in terms of plant height, number of leaves, and branching, while VT3 (60:85:60 NPK) showed enhanced root development. ANOVA results confirmed that the variations in growth parameters across treatments were statistically significant ($P < 0.05$). These findings indicate that moderate nutrient levels (VT1) provide an optimal balance for vegetative and morphological development in mint under vertical hydroponics. The system demonstrated potential for sustainable, space-efficient, and water-saving cultivation, especially in urban and peri-urban settings. Future studies may focus on yield quality, nutrient uptake dynamics, and economic feasibility at commercial scale.

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