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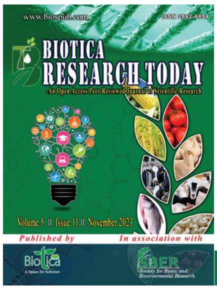

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Unveiling the Future of Urban and Semi-Urban Hydroponic Farming with Nutrient Film Technique

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Abstract

The world is rapidly urbanising and facing challenges with food security, making traditional farming methods unsustainable. By effectively utilising space, water and nutrients, the soilless hydroponic system known as Nutrient Film Technique (NFT) provides a sustainable solution. This article explores the novel features of NFT, shedding light on its adaptability to urban settings, where space and resource constraints frequently make conventional farming impractical. NFT minimises environmental impact while maximising crop yield by continuously supplying nutrients to plant roots. Furthermore, reducing water use and minimising chemical runoff are two of the environmental benefits it addresses. As we approach the dawn of a new agricultural era, this article highlights the promising future of urban and semi-urban hydroponic farming, emphasising NFT as a groundbreaking technique with broad implications for sustainable implications for sustainable food production.

Keywords: Hydroponics, Nutrient film technique, Protected cultivation, Sustainable agriculture

Introduction

Protected cultivation technology is a vital advancement in modern agriculture, playing a pivotal role in ensuring year-round crop production and safeguarding against adverse environmental conditions. This technique involves the use of structures like greenhouses and polytunnels to create a controlled microenvironment for plants, allowing growers to manipulate factors such as temperature, humidity and light to optimize crop growth. Among the various methods employed in protected cultivation, soilless cultivation techniques have emerged as a crucial aspect. Soilless cultivation, also known as hydroponics or aeroponics, eliminates the need for traditional soil, relying instead on nutrient-rich water solutions or inert growing media to support plant growth. It offers innovative solutions to meet the growing demands of sustainable agriculture in an ever-changing climate.

Soilless vegetable cultivation offers a range of significant advantages over traditional soil-based methods. It enables precise control of irrigation water, using only a fraction of the amount needed in conventional soil-based cultivation, typically as low as 10%. Soilless cultivation is remarkably space-efficient, allowing for the simultaneous cultivation of various vegetable types in small areas. With minimal intervals between crops, this method maximizes productivity and income by eliminating the need for time-consuming cultivation operations. Another key benefit is the absence of weed infestation. Soilless cultivation is a sustainable and lucrative choice for modern agriculture (Waiba *et al*., 2020).

The Nutrient Film Technique (NFT) is a closed hydroponic system, where the nutrient solution is recycled and recirculated to supply the plant roots with a highly oxygenated nutrient solution through a channel of PVC pipe arrangements (Arumugam *et al*., 2021). A watertight gully, also known as a channel, is repeatedly used to circulate a narrow stream of water containing the dissolved nutrients required for plant growth past the roots of the plants (Alipio *et al*., 2019). By providing exact control over pH, oxygen levels and nutrient concentrations, this system fosters ideal growth conditions. Because NFT uses water and nutrients efficiently, it is especially well suited for leafy vegetables, which makes it a sustainable option for urban and semi-urban farming.

Article History

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History of Nutrient Film Hydroponics

The hydroponics technique, which has its roots in antiquity, has evolved into the modern Nutrient Film Technique (NFT). The origins of hydroponics can be traced to the fabled Hanging Gardens of Babylon in 600 BCE, where plants flourished in soilless, nutrient-rich water. NFT, as we know it today, was developed by Dr. Allen Cooper in the 1960s in the UK. He improved the method and showed that it was possible to maximize nutrient delivery and promote healthy growth by continuously applying a thin layer of nutrient solution over plant roots. Since then, the NFT system has become more well-known due to its sustainability and efficiency, particularly in urban farming situations.

Technical Design and Operation

A schematic design of Nutrient film type A frame hydroponic system is shown below (Figure 1), along with a brief overview of its various parts.

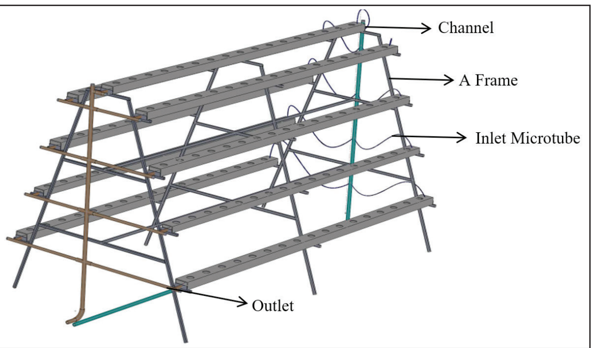

Figure 1: CAD diagram of Nutrient film type A frame hydroponic system

• *A Frame*: Typical options include galvanized steel and aluminium, which are strong, lightweight and resistant to rust. They also provide resistance to moisture and nutrient solutions. On the other hand, PVC products such as pipes and connectors are well-liked due to their accessibility and usability. Another material that might not last as long is wood. The grower's budget, the size of the hydroponic setup and the requirement for structural integrity in a moisture-rich environment are some of the factors that usually determine the choice of material.

• *Channels*: Channels are essential for providing a thin, nutrient-rich film to plant roots in hydroponics' Nutrient Film Technique (NFT). Food-grade plastics like HDPE, aluminium for durability and PVC, which is well-known for its affordability and corrosion resistance, are frequently utilized materials for these channels. Generally, 100 mm × 50 mm, 100 mm × 60 mm, 100 mm × 80 mm are commonly available sizes of rectangular NFT channels. To ensure a successful hydroponic system, the channel size selection should take into account both the available space and the type of crops to be grown.

• *Inlet*: Micro tubes are used to supply water enriched with nutrients from main water supply pipe to individual channels. Common flow rate used is 1 to 1.5 litres minute^{-1}. Micro tubes are flexible with different designs and also, they are not susceptible to choking. By having valves, we can control the flow rate easily.

• *Outlet*: Helps to recirculate the water back to the mixing tank.

Nutrient Reservoir

The nutrient solution is made in a different reservoir and usually contains necessary macro- and micro-nutrients. To guarantee that the plants are receiving the optimum amount of nutrients, the solution's pH and electrical conductivity (EC) are constantly checked and accordingly adjustments are made by adding calculated amount to mixing tank.

Nutrient Recipes

NFT systems are widely utilized worldwide with number of nutrient recipes. These recipes are modified according to the stage of growth and the particular requirements of the crop being grown. Nitrogen (N), phosphorus (P), potassium (K), calcium (Ca), magnesium (Mg) and trace elements such as iron (Fe), manganese (Mn), copper (Cu), zinc (Zn), boron (B) and molybdenum (Mo) are common nutritional components.

Crops Suitable

NFT are perfect for cultivating a wide range of crops, especially those with shallow root systems and high nutrient requirements. Because they grow quickly and require little root space, herbs like basil, mint and cilantro do well in NFT systems. Due to their ease of access to the nutrient-rich water film that is constantly flowing through the channels, leafy greens like spinach and lettuce also do well in NFT arrangements. Furthermore, NFT systems can be used successfully to grow small fruiting plants like peppers, cherry tomatoes and strawberries as long as the right support structures are in place.

Precautions

• *Proper Nutrient Solution*: Make sure the nutrient solution is well-balanced and is suitable for the particular plants being grown. Follow the suggested guidelines and modify the solution according to the plants' stage of growth. By regularly checking and modifying the pH and EC of the nutrient solution, ensure that the plants are absorbing nutrients at their optimal rate. It is customary to use the pH range of 5.5 to 6.5 and the EC range of 0.8 to 1.5 dS m^{-1}.

• *Water Quality*: Test the water supply frequently for possible contaminants, pH levels and nutrient content. In order to avoid system clogging and mineral accumulation, use filtered or purified water. Measuring elements like Na should be used to determine the toxicity of the water; if the result is more than 50 ppm, the solution needs to be adjusted.

• *Temperature Control*: Keep the plants' temperature range within acceptable bounds. Temperature extremes can stress plants and hinder their ability to grow. Install heating or cooling systems as necessary.

• *Pest and Disease Management*: Take preventative action to ward off diseases and pests. Examine plants frequently for indications of pests or diseases and act quickly to address any problems that are found. To prevent chemical contamination, consider using natural or organic pest control methods.

• *System Maintenance*: Make routine checks for leaks, blockages and uneven flow in the NFT system. To avoid obstructions and guarantee that the plants receive a constant supply of nutrients, periodically clean the channels and tubing.

• *Oxygenation*: Make sure the nutrient solution is adequately oxygenated. A lack of oxygen can cause suffocation of the roots among other problems. In order to keep the solution's oxygen levels stable, think about adding air stones or diffusers.

Conclusion

In conclusion, the Nutrient Film Technique (NFT) represents a revolutionary approach to urban and semi-urban hydroponic farming, offering a sustainable solution to the growing demand for fresh produce. By providing continuous, controlled nutrient delivery to plants, NFT maximizes crop yields, quality and resource efficiency. With its historical roots in ancient hydroponic practices and modern development in the 1960s, NFT has become a vital tool in protected cultivation, particularly in urban farming settings. Its technical design and operational considerations, along with attention to nutrient recipes and crop suitability, make it a versatile choice. However, careful monitoring of nutrient levels, water quality, sanitation, temperature and plant health, along with proper training, are essential for successful NFT farming. Embracing NFT technology promises a greener, more efficient and sustainable future for leafy green agriculture.

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