Volume 2, Issue 9
September I 2024

Agri Roots
e- Magazine

www.agrirootsmagazine.in

ISSN: 2583-9071

Space-Age Farming: Role of Aeroponics in Modern Agriculture

ARTICLE ID: 0131

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Through the use of an air and water nutrient fog, whole plants are grown using aeroponics techniques. This method involves fixing plants in holes in Styrofoam panels so that their roots droop below the panels. These panels create an enclosed box to stop light from penetrating and encourage root growth while inhibiting the formation of algae. To keep the roots wet and the nutritional solution aerated, a tiny mist of the solution is sprayed onto them every two to three minutes. The solution film that sticks to a plant's roots is where nutrients and water are absorbed. Innovative agricultural techniques like aeroponics have gained popularity in light of the growing need for food and water resources. Similar to aeroponics, hydroponics is a form of agriculture that involves cultivating plants in a water-based or soilless environment. The yield per unit area is increased by these sustainable farming methods since they use less water, fertilizer, and space. Aeroponics' main benefits include water conservation and little to no usage of agrichemicals, which are dangerous for people, especially if eaten.

Introduction

A revolution in agricultural productivity is on the horizon thanks to advancements in precision dosing, ML, robotics, process automation, genome engineering, and protected farming (Rose & Chilvers, 2018; Klerkx & Rose, 2020). The horticultural sector has experienced rapid growth in indoor farming, primarily because of its ability to regulate environmental conditions and produce consistent outcomes (Benke & Tomkins, 2017).

Plant roots in aeroponics are exposed to aerosol particles containing nutrients (Fig. Aeroponics

system). A collection of solid particles or liquid droplets suspended in a gas phase within an aeroponics environment (Hinds, 1999). High-pressure nebulization, in which highly compressed liquids are propelled through a minute opening to break the flowing liquid into trickles, is the most commonly used aerosol-producing approach in horticulture. This usually results in aerosol particles that range from 10 to 100 µm (Lakhiar *et al*., 2018).

Aeroponics

Aeroponics is the cultivation of plants in an environment filled with air or moisture, without the use of soil or other aggregate media (NASA Spinoff, 2006). Complete automation, portability, global access monitoring, and error detection for residential or commercial farming are primary principles of an aeroponic greenhouse in smart environment. Aeroponic plants are nourished by a water-based nutrient solution misted onto their lower stems and suspended roots several times each hour. Aeroponics systems offer a significant benefit in nutrient delivery: the plant is housed in a relatively contained environment, which slows the spread of diseases. Aeroponics also offer advantage of reducing rooting periods and accelerating growth, as suspended plants can access abundant carbon dioxide and oxygen in their root zones, leaves and stems (Martin Pala *et al*., 2014).

Aeroponics' growing chamber and fertigation system enables total control over the rhizosphere, including humidity, temperature, and frequency and length of mist application. Because of this, plants cultivated aeroponically frequently show faster development and earlier maturity (Mirza *et al*., 1998).

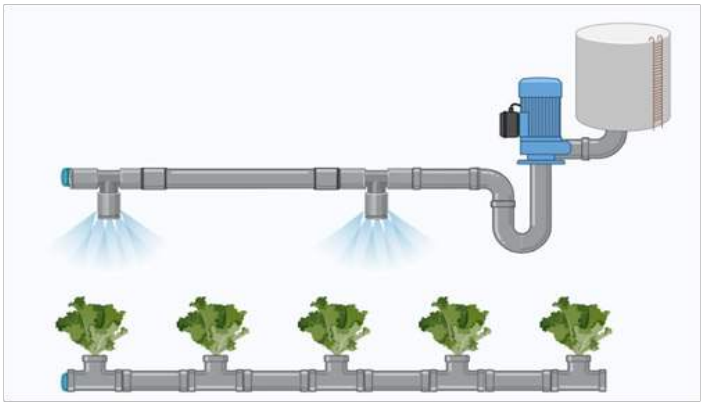

Fig.1: Nutrient supplied through mist spray

Requisites of Aeroponics System

It is important to regulate the temperature of the nutrient solutions and air in an aeroponics system to promote quick plant development (107 | 1-3 | 3). Elevated temperatures cause chemical reactions to occur more quickly, leading to a decline in enzyme activity. The optimal heat range for all plants is between 15 and 25°C. However, temperatures in growth chambers should range between 4°C to 30°C (Otazú, 2014).

In an aeroponics system, humidity is critical to the healthy growth and development of plants. But relative humidity variations have a big effect on how plants develop (Ford and Thorne, 1974; Schussler, 1992).

An innovative technique in agriculture today for growing plants without soil is called aeroponics. Via a nutrition spray mist released by atomizing nozzles, this technology provides vital nutrients to the plants. As a result of atomization, liquid molecules are divided into tiny droplets (Avvaru *et al*. 2006). Pressurized water is sprayed into the plant roots of aeroponic systems most frequently using garden nozzles similar to those seen on sprinkler systems.

Root Zone O_2 Availability

By promoting root respiration, root zone aeration greatly increases plant productivity (Armstrong, 1980; Soffer *et al*., 1991). Because roots may potentially access all of the oxygen in the rhizosphere, the aeroponic approach offers a clear benefit.

Root Morphology

Aerosol capture and thin-film formationare being influenced by root morphology and architecture. Aeroponically produced root, for example, could certain more root hair than hydroponically (Kratsch *et al*., 2006), thereby influencing aerosol capture.

Advantages

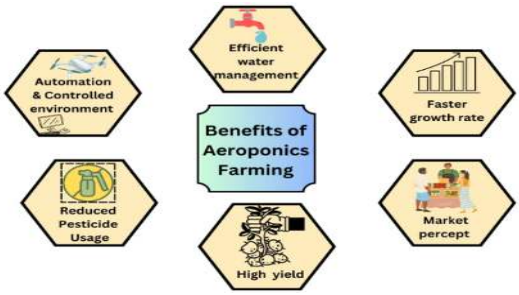

Fig. 2: Elevating harvest by using the benefits of aeroponics farming

The Aeroponics method may reduce fertilizer usage by 60%, reduce water usage by 98%, and eliminate pesticide use, maximizing crop yields. Plants cultivated in aeroponics systems have demonstrated an increased uptake of minerals and vitamins, leading to healthier and potentially more nutritious plants. Plants can be transplanted more easily due to the absence of transplant shock, providing more options. Additionally, aeroponics enables direct plant observation without disturbance, allowing adjustments to the nutrient mix and early intervention to address any potential issues.

Conclusion

Aeroponics might be a useful technique in areas without access to freshwater and rich soil. This approach may be a workable way to produce food in places like desert regions that have a lot of non-arable land, a small amount of space, and a high population. Additionally, it can increase the accessibility and usage of vegetables andfruits per capita. Aeroponics, on the other hand, requires habitats that range from semi-enclosed to fully enclosed, needing more upkeep and cautious supervision.

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