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Hydroponics As an Advanced Technique for Vegetable Production

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Abstract

Currently hydroponic cultivation is gaining popularity all over the world because of efficient resources management and quality food production. Soil based agriculture is now facing various challenges such as urbanization, natural disaster, climate change, indiscriminate use of chemicals and pesticides which is depleting the land fertility. In this article various hydroponic structures viz. wick, ebb and flow, drip, deep water culture and Nutrient Film Technique (NFT) system; their operations; benefits and limitations; performance of different crops like tomato, cucumber, pepper and leafy greens and water conservation by this technique have been discussed. Several benefits of this technique are less growing time of crops than conventional growing; round the year production; minimal disease and pest incidence and weeding, spraying, watering etc can be eliminated. Commercially NFT technique has been used throughout the world for successful production of leafy as well as other vegetables with 70 to 90% savings of water. Leading countries in hydroponic technology are Netherland, Australia, France, England, Israel, Canada and USA. For successful implementation of commercial hydroponic technology, it is important to develop low-cost techniques which are easy to operate and maintain; requires less labour and lower overall setup and operational cost.

Keywords: Nutrient Film Technique (NFT), water conservation, nutrient management, Hydroponic market

Introduction

Hydroponics is a technique of growing plants in nutrient solutions with or without the use of an inert medium such as gravel, vermiculite, rockwool, peat moss, saw dust, coir dust, coconut fibre, etc. to provide mechanical support. The term Hydroponics was derived from the Greek word's hydro' means water and ponos' means labour and literally means water work. The word hydroponics was coined by Professor William Gericke in the early 1930s; describe

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the growing of plants with their roots suspended in water containing mineral nutrients. Researchers at Purdue University developed the nutriculture system in 1940. During 1960s and 70s, commercial hydroponics farms were developed in Arizona, Abu Dhabi, Belgium, California, Denmark, German, Holland, Iran, Italy, Japan, Russian Federation and other countries. Most hydroponic systems operate automatically to control the amount of water, nutrients and photoperiod based on the requirements of different plants.

Due to rapid urbanization and industrialization not only the cultivable land is decreasing but also conventional agricultural practices causing a wide range of negative impacts on the environment. To sustainably feed the world's growing population, methods for growing sufficient food have to evolve. Modification in growth medium is an alternative for sustainable production and to conserve fast depleting land and available water resources. In the present scenario, soil less cultivation might be commenced successfully and considered as alternative option for growing healthy food plants, crops or vegetables. Agriculture without soil includes hydro agriculture (Hydroponics), aqua agriculture (Aquaponics) and aerobic agriculture (Aeroponics) as well as substrate culture. Among these hydroponics techniques is gaining popularity because of its efficient management of resources and food production. Various commercial and specialty crops can be grown using hydroponics including leafy vegetables, tomatoes, cucumbers, peppers, strawberries, and many more. This article covers different aspect of hydroponics, vegetables grown in hydroponics system and global hydroponic market.

Hydroponic Structures and Their Operation

Hydroponic system is customised and modified according to recycling and reuse of nutrient solution and supporting media. Commonly used systems are wick, drip, ebb-flow, deep water culture and nutrient film technique (NFT) which are described below.

1 Wick System
2 Ebb and Flow system
3 Drip irrigation system
4 Deep water culture
5 NFT (Nutrient film technique)

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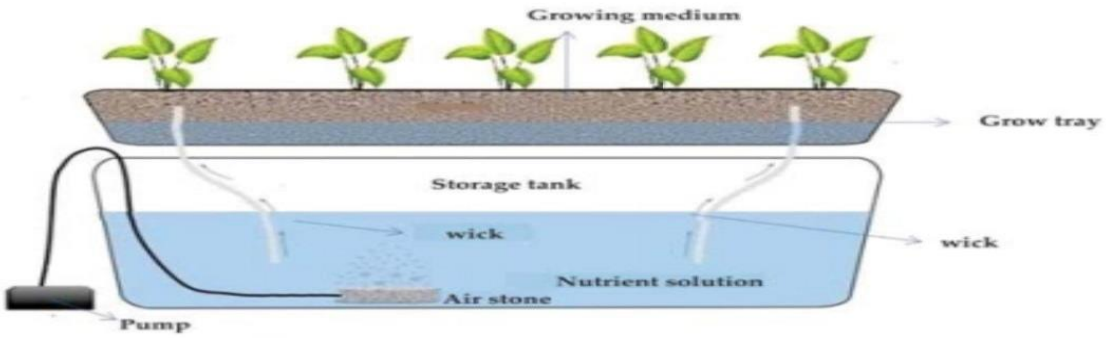
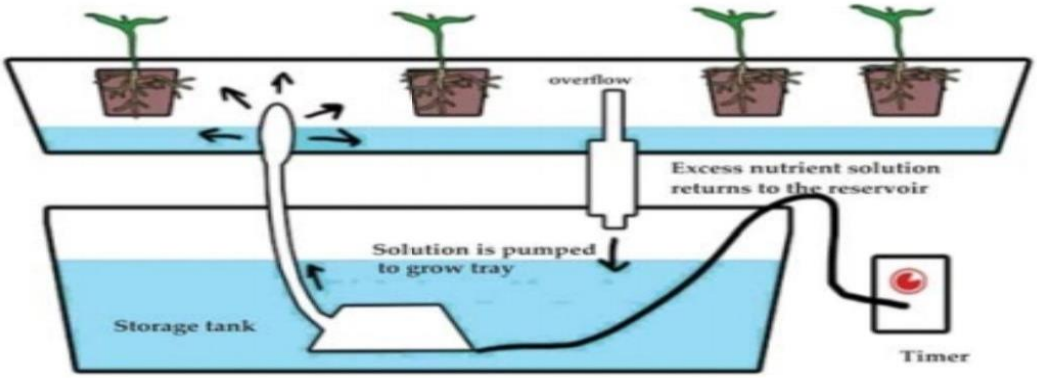
1 **Wick System: -** This is simplest hydroponic system requiring no electricity, pump and aerators. Plants are placed in an absorbent medium like coco coir, vermiculite, perlite with a nylon wick running from plant roots into a reservoir of nutrient solution. Water or nutrient solution supplied to plants through capillary action. This system works well for small plants, herbs and spice and doesn't work effectively that needs lot of water.



Wick System

2 **Ebb and Flow system: -** This is first commercial hydroponic system which works on the principle of flood and drain. Nutrient solution and water from reservoir flooded through a water pump to grow bed until it reaches a certain level and stay there for certain period of time so that it provides nutrients and moisture to plants. Besides, it is possible to grow different kinds of crops but the problem of root rot, algae and mould is very common therefore, some modified system with filtration unit is required.



Ebb & Flow System

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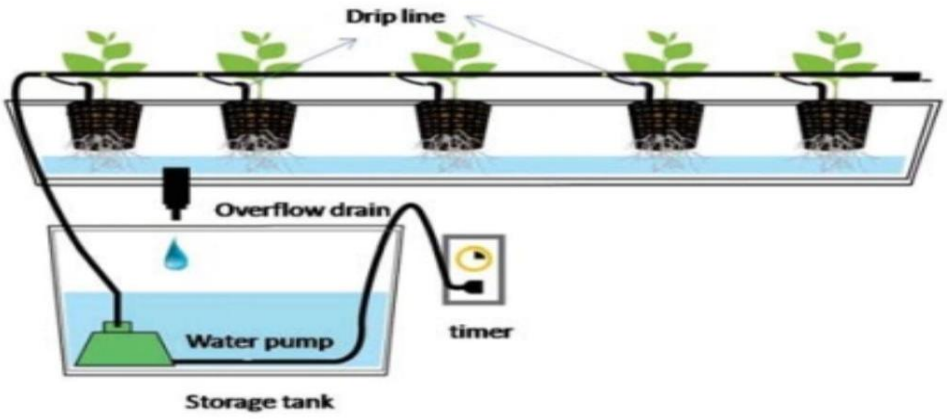
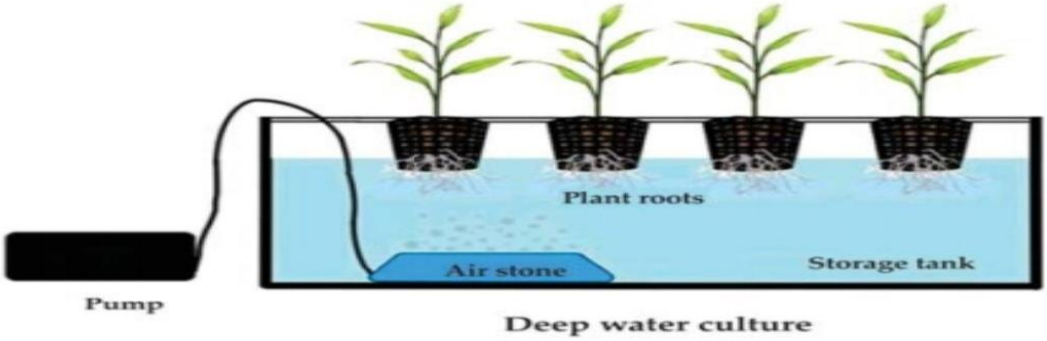
3 **Drip irrigation system: -** The drip hydroponic system is widely used method among both home and commercial growers. Water or nutrient solution from the reservoir is provided to individual plant roots in appropriate proportion with the help of pump. Plants are usually placed in moderately absorbent growing medium so that the nutrient solution drips slowly. Various crops can be grown systematically with more



Drip system

conservation of water.

4 **Deep water culture system :-** In deep water culture, roots of plants are suspended in nutrient rich water and air is provided directly to the roots by an air stone. Hydroponics buckets system is classical example of this system. Plants are placed in net pots and roots are suspended in nutrient solution where they grow quickly in a large mass. It is mandatory to monitor the oxygen and nutrient concentrations, salinity and pH as algae and moulds can grow rapidly in the reservoir. This system work well for larger plants that produce fruits especially cucumber and tomato, grow well in this system.



Deep water culture

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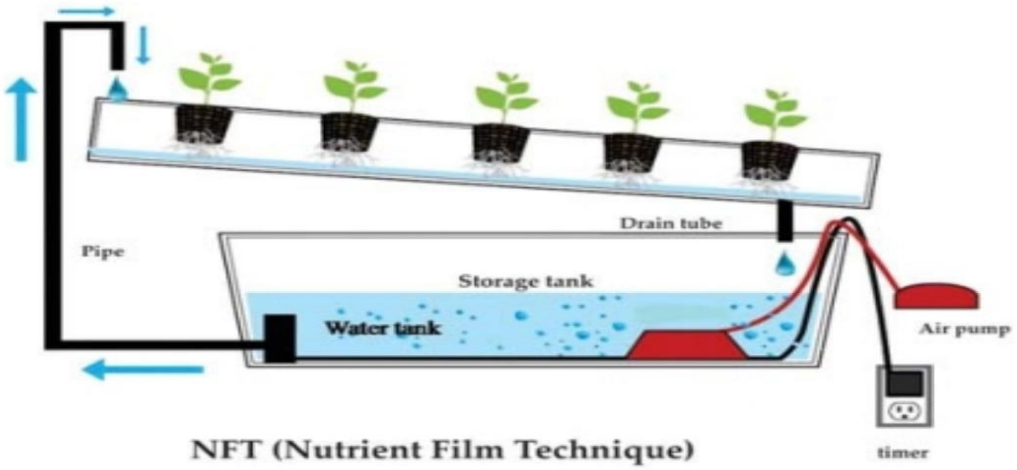
5 **Nutrient Film Technique (NFT) system: -** NFT was developed in the mid-1960s in England by Dr. Alen Cooper to overcome the shortcomings of ebb and flow system. In this system, water or a nutrient solution circulates throughout the entire system; and enters the growth tray via a water pump without a time control. The system is slightly slanted so that nutrient solution runs through roots and down back into a reservoir. Plants are placed in channel or tube with roots dangling in a hydroponic solution. Although, roots are susceptible to fungal infection because they are constantly immersed in water or nutrient. In this system, many leafy greens can easily be grown and commercially most widely used for lettuce production.



NFT (Nutrient Film Technique)

Benefits and Limitations of Hydroponics

Recently hydroponic technique is becoming popular because this is clean and relatively easy method and there is no chance of soil-borne disease, insect or pest infection to the crops thereby reducing or eliminating use of pesticides and their resulting toxicity. Besides, plants require less growing time as compared to crop grown in field and growth of plant is faster as there is no mechanical hindrance to the roots and the entire nutrient are readily available for plants. This technique is very useful for the area where environmental stress (cold, heat, dessert etc) is a major problem. Crops in hydroponic system are not influenced by climate change therefore, can be cultivated year-round and considered as off season. Further, commercial hydroponic systems are automatically operated and expected to reduce labour and several traditional agricultural practices can be eliminated, such as weeding, spraying, watering and tilling. Hydroponics saves large amount of water as irrigation and other kind of sprays is not needed and water logging never occurs. The problem of pest and disease can be controlled

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easily while weed is practically non-existent. Higher yields can be obtained since the number of plants per unit is higher compared to conventional agriculture. Although soil-less cultivation is an advantageous technique but some limitations are significant. Technical knowledge and higher initial cost is fundamental requirement for commercial scale cultivation. Plant in a hydroponics system is sharing the exact same nutrient, and water borne diseases can easily spread from one plant to another. Hot weather and limited oxygenation may limit production and can result in loss of crops. Maintenance of pH, EC and proper concentration of the nutrient solution is of prime importance. Finally, light and energy supply is required to run the system under protected structure.

Various species of plants grown under soil less hydroponic system

Type of crops	**Name of the crops**
Cereals	Rice, Maize
Fruits	Strawberry
Vegetables	Tomato, Chilli, Brinjal, Green bean, Beet, Winged bean, Bell pepper, Cucumbers, Melons, green Onion
Leafy vegetables	Lettuce, Spinach, Celery, Swiss chard, Atriplex
Condiments	Coriander leaves, Methi, Parsley, Mint, Sweet basil, Oregano
Flower / Ornamental crops	Marigold, Roses, Carnations, Chrysanthemum
Medicinal crops	Indian Aloe, Coleus
Fodder crops	Sorghum, Alfa alfa, Bermuda grass, Carpet grass

Conclusions: -

In recent years hydroponics is seen as a promising strategy for growing different crops. As it is possible to grow short duration crop like vegetables round the year in very limited spaces with low labour, so hydroponics can play a great contribution in areas with limitation of soil and water and for the poorer and landless people. In India, the hydroponic industry is expected to grow exponentially in near future. To encourage commercial hydroponic farm, it is important to develop low-cost hydroponic technologies that reduce dependence on human labour and lower overall startup and operational costs.

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