

Urban based Agriculture using Aeroponic Technology

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Abstract - With increasing demand on technological development and westernization of cities, availability of land and water (that is fit for irrigation) diminishes day by day. Further, the cost and fertility of land in city makes it impossible for crop cultivation to flourish in city. In this paper on "Aeroponic cultivation", we focus on growing plants in a soil free medium in the absence of natural sunlight. The method involves indoor gardening techniques ruling out the atmospheric consideration for safe agriculture. Vertical stack farming facility improves yield within a controlled premise. The soil free cultivation environment provides no home for any insects; therefore, pesticides free organic fruits and vegetables are easily harvested. The system involves the consumption of only 10% of water used in the conventional agriculture. The energy needed by a plant from natural sunlight is provided by using special Light Emitting Diode (LED) growth light. Such growth lights emit the specific wavelength range depending on the plant's requirement, therefore enhancing the quality of cultivation. The nutrient solution is chosen carefully to meet all the fertility demands of the plant. Plants for cultivation must be technically chosen and short listed based on its adaptability to the technique. The technique mainly aims at providing fruits and vegetable at any part of world as it is temperature independent. The controlled process of cropping enhances the quality of the growth and product of the plant.

Key Words: Aeroponic cultivation, soil free medium, LED, Nutrient Solution, temperature independent.

1. INTRODUCTION

Agricultural land is reducing day by day due to growing population needs. It is a challenge for a farmer to provide food to such a great population with the available land and water. Aeroponic cultivation method focuses on growing plants in a soil free medium under the absence of sunlight.

In this method, the plant roots are constantly misted with nutrient solution. The parameters to be controlled are temperature, humidity, pH and electrical conductivity of nutrient solution etc. resulting in a conditioned environment. The benefits of using aeroponics is growing healthier and nutritious roots by consuming fewer amount of nutrients and water. By adopting this technique fresh and healthier product are harvested throughout the year.

Such controlled environment has a strong potential to improve plant's developmental stages, health and growth. Aeroponic system has more advantage than hydroponic in terms of spraying high air content in the nutrient solution to provide oxygen to plant roots. The focus of attention variables in the aeroponic system research are

1. Micro environment – Temperature, humidity and pH.
2. The effectiveness of nutrition – spraying or fogging.

Further, production of pesticides free product with the consumption of comparatively very minimal water content makes it an ideal choice for urban cultivation. Cultivation of crop under such controlled environment enhances the product's and the technique's quality.

Aeroponic system is an endless process in a confined space and therefore it cuts down agricultural labour. A monitoring and controlled system intended for water and nutrient distribution must be designed to support the optimal application of aeroponic cultivation system for plant. The success of this technique depends on a well-built system, understanding of the system's technicalities and a measure of nutrients needed for various plants that you grow.

2. HISTORY OF AEROPONICS

Soilless planting technique were first developed in 1920s by botanist. An elaborate study on root structures was the main purpose behind their research. Soil free medium made their study easier. The technique of aeroponic is developed from hydroponics. In 1957, Went coined the term Aeroponics to describe air-growing process of coffee plants and tomato with their roots being suspended in air medium followed by a supply of nutrient mist directly to the roots. In hydroponic, uses nutrient rich solution acts as a growing medium in which plant's roots are immersed. This technique became popular in 1970s. In 1990s NASA involved in aeroponic technique. After a detailed research study, NASA funded a small project for aeroponics. Thus, aeroponic gain popularity through NASAs initiative.

In 1997, NASA tested one system of Asian bean aeroponically at MIR Space station and the other at Earth. Gravitational force was the only thing that separated these two systems. Crops at zero gravity grew better. Hence the results proved that, aeroponically food crops can grow and flourish at zero gravity.

Today Scissortail Farms in Tulsa, Oklahoma is one of the world's largest aeroponic farms with a capacity of 62,000 plants. The vertical aeroponic tower system is adopted produce fresh food for the region which would otherwise be shipped from California or Arizona. It consumes up to 95% less water and 90% less land than conventional farming. More importantly the system use is no harmful chemicals or herbicides thereby, producing completely safe organic crops. Similarly, Aero Farms in New York began in at Finger Lakes area. Aero Farms uses it patented aeroponic growing system to grow a variety of produce. Aero Farms began its seeding at its global headquarters – of 70,000 sq. ft indoor vertical farm.

3. CHALLENGES IN CONVENTIONAL AGRICULTURE

Conventional agriculture is the largest single non-point source of water pollutants including sediments, salts, fertilizers (nitrate & phosphorous) and pesticides. Eutrophication and dead zones due to nutrient run-off, affect many rivers, lakes and oceans. Reduced water quality impacts agricultural production, drinking water supplies and fishery production. Further, the farmers are restricted to cultivate during the off-seasons of a particular crop.

Due to conventional agricultural activities, the soil and land may degrade because of human mismanagement of soils. A report on the global assessment of soil degradation states that, “the earth's soils are being washed away, rendered sterile or contaminated with toxic chemicals at a rate that cannot be sustained”. Today almost a quarter of the earth's farmland is affected by such serious degradation. Hence, it can be stated that conventional agriculture method further depletes the soil and renders it sterile. Therefore, alternatives must be thought of to protect the available land.

This smart speaking energy meter we monitor the energy or power usage by a remote technology using IOT. Since it doesn't have any physical contact with the equipment. The degree of accuracy in the way of measuring the energy is very high.

4. SOILLESS AGRICULTURE

There are so much discussion surrounding the three soilless agriculture system sweeping the globe today namely – Hydroponics, Aeroponics & Aquaponics. However, there are many significant differences between these three techniques.

The cost of fertilizers used to supply nutrients to the roots in hydroponic system is expensive when compared to aquaponics which depends on fish waste for nutrient supply. Although, aeroponics and hydroponics are similar in using nutrient rich water, hydroponic uses certain media other than soil to retain and distribute nutrients to the plants and

aeroponic uses misting system to deliver the nutrients. Unlike any other technique, aeroponic succeeds maximum yield per unit area through vertical growing arrangement.

Hydroponics uses only 10% of water resources when compared to conventional method. With no growing medium and nutrient rich mist atmosphere aeroponic system reduces water usage by 98%, fertilizer usage by 60% and pesticides usage by 100%, while maximizing crop yields.

Aquaponics would require a more frequent monitoring on the ammonium content from the fish waste and periodic cleaning, making its maintenance more complex. While on the other hand hydroponics due to stagnation of nutrient rich solution there are possibilities for the spread of disease to the plants and surroundings.

The flexibility of aeroponics to take up vertical cultivation allows greater yield per unit area, encouraging maximum utilization of the available area. Also, the indoor gardening facility restricts the dependency of plants to external environmental conditions, thereby promoting controlled cultivation.

5. AEROPONIC CHAMBER

The aeroponic chamber is made up of a number of important components namely - the nursery tray with aeroponic kit, pipe connections, motor with timer arrangement, irrigation and nutrient solution and LED lighting system.

5.1 NURSERY TRAY AND AEROPONIC KIT

Containers or nursery trays are used to facilitate seed germination (in a soilless medium) and to provide the required stability for the plant. The selection of these trays must be done carefully such that it retains the nutrient solution, irrigation system and as well as the aeroponic kit.

Aeroponic kits are the holding elements, that holds the plants in the predefined positions. The kits are suspended on or above the container with sufficient gaps and hole to allow the necessary root growth.



Fig-1: Aeroponic kit

5.2 PIPE CONNECTIONS

PVC pipes are connected with appropriate joint arrangement for the flow of nutrients from the nursery tray or container. These pipes are held in position, forming the frame structure of the container. The joint ends are sealed with the use of joint solution.



Fig-2: Growth Chamber

5.3 MOTOR WITH TIMER ARRANGEMENT

The nutrient solution from the container is lifted up to the sprinklers through the PVC pipe system with the help of motor connection. Nutrient solution in the container is filled until the motor is well submerged in order to drive the water up.

Since the aeroponic system needs periodic recirculation of the nutrients, a timer facility is important. The timer works in such a way that the motor is operated for the particular pre-programmed duration of time. The programming of ON and OFF in the timer is important for the optimum supply of nutrients to the roots directly.



Fig- 3: Electronic Timer

5.4 NUTRIENT SOLUTION AND IRRIGATION SYSTEM

Nutrient solution is synthesized by mixing a particular quantity of each nutrient with measured amount of water. The ratio of the selected nutrients widely varies with different plants. A detailed study on the plant's need may help in determining the nutrient ratio.

Irrigation system comprises of suitable combination of 180° and 330° sprinklers to properly moisturize the roots with required nutrients. These sprinklers are placed appropriately to efficiently meet the nutrient needs of the crop selected.

5.5 LED GROWTH LIGHTS

LEDs as an illumination source in any indoor garden are much more suitable than other grow lights whose peak emissions widely differ from the absorption spectrum of plants. LEDs allow the growers to pick the spectrum of light they want, rather than relying on whatever colors the phosphors happen to make, are what color sodium glows at when it gets really warm.



Fig-4: LED Growth light

6. ADVANTAGES

1. Aeroponic technology gives high yield with less space requirements.
2. Early and easy harvest of crops can be done.
3. Plants can be grown at zero gravity (at space) through aeroponic method.
4. Water consumption is greatly reduced to about 98% when compared to the conventional method.
5. By this technique fresh and healthy fruits and vegetables can now be grown indoors and rooftops.
6. Higher consumption of oxygen is achieved under aeroponic condition, thereby enhancing plant growth.
7. Being independent on external temperature conditions, in this method plants can be grown throughout the year.
8. Grown under clean and controlled conditions, the harvests from this method are highly fresh and organic.

9. The soilless cultivation method provides no home for pests thereby, reducing the pesticide usage by 100%
10. The no soil requirement of the system enables crop cultivation even in cities.

7. DISADVANTAGES

1. Higher demand and consumption of electricity, makes the technique uneconomical.
2. Taking up aeroponic cultivation method requires technical knowledge about the plant and its demands and about the method itself.
3. Continuous and periodic monitoring of the entire system setup followed by proper sanitary maintenance are high demands of the method.

8. CONCLUSION

Aeroponic is an inevitable method of cultivation in the areas where little arable land is available and is an efficient method of cultivation for better utilization of water and nutrients. Aeroponics is a blessing to the cultivation system as it conserves water and avoids use of agrichemicals. This method is inclined to organic farming practices which fetch a better price than the inorganic food procedure.



Fig-6: Aeroponic Final Setup

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