SMART IRRIGATION USING HYDROPONICS

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Abstract : Many of us think that all veggie gardens have to look alike, with rows and mounds of dirt, but vegetable gardening isn't limited to this anymore. In fact, many of the fresh fruits and vegetables you buy in the store are grown hydroponically, especially during the winter months or in colder climates. Hydroponics is a method of growing crops without soil. Plants are grown in rows or on trellises, just like in a traditional garden, but they have their roots in water rather than in dirt.
Most of us confuse soil with nutrients. In fact, soil provides structure, not the actual food itself, for plant roots. The food comes from other materials mixed in the soil, such as compost, broken-down plant waste or fertilizers. Plants grown hydroponically can actually grow faster and healthier than plants in soil because they don't have to fight soil borne diseases; in addition, all the food and water they need are given directly to their roots around the clock. The objectives of our present study are to explain the meaning of hydroponics and describe some of its advantages, to describe how hydroponic system differs from traditional system, to identify advantages of hydroponics over soil based system, to identify basic requirements of hydroponically grown plants and to suggest optimum dosage of stabilizer for soil improvement levels.

1. INTRODUCTION

General :

The word hydroponics comes from the Greek for "working with water," and is a method of growing plantsin nutrient-rich liquid instead of soil. This can be done outside during warm weather or indoors year-round, and has many advantages, including no weeding, fast growth, high yields in small space, clean vegetables, easy to harvest, consistent quality and no soil related diseases. One of the greatest things about hydroponics is that it can be done in a tiny space—a balcony or terrace, a small yard, the rooftop of an apartment building, and even indoors. Since it's a selfcontained system, a hydroponics setup can be scaled to any size you like (bearing in mind the weight of the water) to provide for yourself, yourself and a friend, or your family. Taking into account how much you want to spend, the plants you want to grow, and how high-tech you want to go, there are many options to choose from.

Figure 1.1 Hydroponic in Mauritius.

In Comparison to conventional method of cropping system, the hydroponic system proves to be using less amount of water, faster growth of plant, more productive and healthy plants growing system.

1.2 HISTORY OF HYDROPONICS

The earliest examples of hydroponics date back to the Hanging Gardens of Babylon and the Floating Gardens of China. Humans used these techniques thousands of years ago. Although the general theory behind hydroponics remains the same, modern technology has enabled us to grow plants faster, stronger, and healthier. The first known instance of water-based hydroponics is in the Hanging Gardens of Babylon, one of the Seven Wonders of the Ancient World.

Figure 1.2 Babylon Hydroponics

The gardens thrived off of an elaborate watering system that supplied a steady stream of river water rich in oxygen and minerals. Located on the East bank of the Euphrates River near present dayBaghdad, the gardens were built by King Nebuchadnezzar II (604–562 BC) to please his wife Amyitis. Similarly, ancient Egyptian hieroglyphics dating back to several hundred years BC depict the growing of plants along the Nile River without soil, as do the floating gardens of the Chinese, as described by Marco Polo in his famous journal.

1.3 DEVELOPMENT IN HYDROPONICS

The earliest modern reference to hydroponics (last 100 years) was by a man named William Frederick Gerick. While working at the University of California, Berkeley, he began to popularize the idea that plants could be grown in a solution of nutrients and water instead of soil. He decided to call this growing method hydroponics.
The shocking results of Gerick's experiment with tomatoes prompted further research into the field. More research was performed by University of California scientists, who uncovered a great deal of benefits related to soilless plant cultivation.

Figure 1.3 William F. Gerick

One of the earliest successes of hydroponics occurred on Wake Island, a rocky atoll in the Pacific Ocean used as a refueling stop for Pan American Airlines. Hydroponics was used there in the 1930sto grow vegetables for the passengers. Hydroponics was a necessity on Wake Island because there was no soil, and it was prohibitively expensive to airlift in fresh vegetables

Figure 1.4 Wake Island Hydroponics.

In the 1960s, Allen Cooper of England developed the Nutrient film technique. The Land Pavilion at Walt Disney World's EPCOT Center opened in 1982 and prominently features a variety of hydroponic techniques. In recent decades, NASA has done extensive hydroponic research for its Controlled Ecological Life Support System (CELSS). Hydroponicsresearch mimicking a Martian environment uses LED lighting to grow in a different color spectrum with much less heat. Ray Wheeler, a plant physiologist at Kennedy Space Center's Space Life Science Lab, believes that hydroponics will create advances within space travel, as a bioregenerative life support system.

Figure 1.5: Nasa Researchers checking Hydroponic Crops.

In 2007, Eurofresh Farms in Willcox, Arizona, sold more than 200 million pounds of hydroponically grown tomatoes. Eurofresh has 318 acres (1.3 km2) under glass and represents 6 | P a g e about a third of the commercial hydroponic greenhouse area in the U.S. Eurofresh tomatoes were pesticide-free, grown in rockwool with top irrigation. Eurofresh declared bankruptcy, and the greenhouses were acquired by NatureSweet Ltd. in 2013.

Figure 1.6: Tomatoes at Euro Fresh Farms in Arizona

1.4 REVENUE DUE TO HYDROPONICS

Due to technological advancements within the industry and numerous economic factors, the global hydroponics market is forecast to grow from US$226.45 million in 2016 to US$724.87 million by 2023

Figure 1.7: Modern Hydroponic Methods in Cincinnati, USA.

2. OBJECTIVE

The project deals with study of Hydroponics for Urban farming. All necessary introductory information is provided to carry out Hydroponic study. It helps us to identify how this system differs with other traditional system of crop cultivation i.e soil-based irrigation. Also, a complete over view of hydroponically grown plants and suggestions for optimum dosage of stabilizer for soilimprovement levels is studied in detail.

3. LITRATURE REVIEW

Preliminary Remarks

During the literature review for this work, we have referred quite a few text and reference books on Irrigation engineering; and technical and research papers from various national and international journals. This part focuses on the literature of improvement of soil using demolishedconcrete waste and recycled plastic polymer

Review of Literature

Raneem Gashgari, Khawlah Alharbi, Khadija Mughrbil, Ajwan Jan, Abeer Glolam (2018) had conducted study on soil and hydroponic based system. The study was done on cucumbers. It was found out that there was a significant increase in yields of

cucumber when grown in hydroponic system. The yield was 20% to 25% higher than that of soil based system.

Abdullah al Ghafri (2018) provided with general details, advantages, disadvantages, types and methods and provides all the essential details related to hydroponic system. It helped to know which are various methods of hydroponic that are widely used worldwide along with essential requirements, materials required and the entire procedure of various hydroponic methods.

Chenin Treftz, Stanley T. Omaye (2015) study was done in strawberries production using soil based system and hydroponic system. It was seen that higher production was seen in hydroponic system with low pesticide usage. There was also higher survival rates in hydroponic system for crops than soil based system.

Sagar J. Dholwani, Sagar G. Marwadi, Vandan P. Patel, Vijeta P. Desai (2018) had determined and compared various hydroponic methods and gave the suitability of each method for various types of crops and conditions. It is seen that it is essential to provide each type of crop with its ownmethod for quality results.

Y.N. Chow, L.K. Lee, N.A. Zakaria, K.Y. Foo (2017) had provided with differences between traditional and hydroponic system. it gave effects of pollutants on plants and crops in both traditional and hydroponic system. it provided with preventive measures and care that should be taken to prevent crops from damage and lowering its yield.

Vikas, Anjil Kumar, Arun Kumar, Anshu Singh, Praveen Kumar, Jaihoon Rafie, Parkash Verma and Ajay Kumar (2017) the test was conducted on strawberries and it was found out that concentration of nutrients on strawberries mayhave good or adverse effects on its quality and yielddepending upon the fact that whether the concentration of nutrients were used wisely or unwisely.

A. Giro , S. Ciappellano, A. Ferrante (2016) had performed the hydroponic system inside the deadcity of Cairo. Tomato cultivation was done in a very cost effective manner and thre was also a comparison of pertile and peat combination and soil and sand combination.

Mamta D. Sardare, Ms. Shraddha V. Admane (22013) had provided with basic information abouthydroponic farming and helps to understand the contribution of hydroponics with respect to currentworld situations. Most importantly it helps to understand basic objective of hydroponic farming and its use.

H. Ramírez-Gómeza, M. Sandoval-Villa (2012) had conducted a cultivation comparative test on strawberry production it was found out that the yield of strawberries were increased when the hydroponic system was employed it also introduced various methods of strawberry production.

4. METHODOLOGY

This study will demonstrate successful cultivation of fruits like strawberries and the cucumber with also vegetables like tomato, lettuce and spinach.
Hydroponic system can either be active or passive. Active means that nutrient solutions will be moved usually by a pump. Passive relies on wick or the anchor of growing media.In this study the active system of hydroponics will be in use. The system of nutrient film techniquewill be employed. Nutrient film technique (NFT) is a 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.A properly designed NFT system is based on using the right channel slope, the right flow rate, andthe right channel length. The plant roots are exposed to adequate supplies of water, oxygen and nutrients. The NFT technology of hydroponic system will be used either in the form of flatbed system or vertical system.

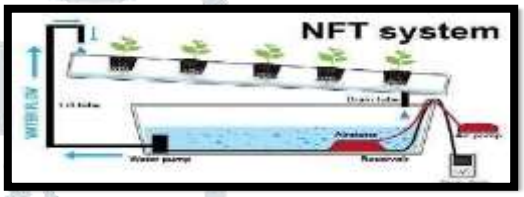


Figure 4.1 Nutrient Film Technique

4.1 EQUIPMENT AND MATERIALS:

In order to build an efficient nutrient film technique of hydroponic cultivation following materialsare required

STEPWISE PROCEDURE FOR INSTALLATION OF ASSEMBLY

Following step-wise methodology is used during hydroponic cultivation

Step 1: Assemble the Hydroponic System

The system consists of six growing tubes made of 6" PVC pipe, a stand and trellis made of PVC, a 50-gallon nutrient tank, a pump and a manifold. The tank sits under the table of 6" PVC growingtubes, and the pump sits inside the tank to push nutrients up to the plants via a manifold of smallerPVC pipes and plastic tubes. Each growing tube has a drainpipe that leads back to the tank. The manifold sits on top of the pipes and sends pressurized water to the tubes. To get the nutrients to the plants in this system, water is pushed through a square of PVC, the manifold, and then gets shot out to small plastic tubes that run inside each of the larger growing tubes. The nutrient tubes have very small holes in them, one hole between each plant site. The nutrients shoot out the hole and spray the plant roots. At the same time, the jet of water makes air bubbles so the plants get enough oxygen.

Figure 4.2 Assembled Nutrient Film Technique

Step 2 : Mix the Nutrients and Water in the Tank

Fill the 50-gallon tank with water. Then add two cups of nutrients to the tank (or as recommended by the fertilizer label), turn on the pump and let the system run for about 30 minutes to get all of the nutrients thoroughly mixed.

Figure 4.3 Mixing of Nutrient and Water in Tank

Step 3: Add Plants to the Growing Tubes

One of the easiest ways to plant a hydroponic garden is to use purchased seedlings, especially if you don't have time to grow the seeds yourself. The key is to choose the healthiest plants you canfind and then remove all of the soil off their roots. To wash the dirt off the roots, submerge the root ball in a bucket of lukewarm to cool water (Image 1). Water that's too warm or too cold can send the plant into shock. Gently separate the roots to get the soil out. Any soil left on the roots could clog up the tiny spray holes in the nutrient tubes.After the roots are clean, pull as many roots as you can through the bottom of the planting cup andthen add expanded clay pebbles to hold the plant in place and upright. The expanded clay pebblesare hard, but they're also very light so that they don't damage the plant roots

Figure 4.4 Plants Added to Growing tubes

Step 4: Tie the Plants to the Trellis

Use the plant clips and string to tie the plants to the trellis. The string will give them support to climb straight up, which helps to maximize the space in this confined area. Tie the string loosely to the top of the trellis attach the clips and string to the base of each plant and gently wind the tipsof the plants around the string.

Figure 4.5 Plants Tied to Trellis

Step 5: Turn on the Pump and Monitor the System Daily

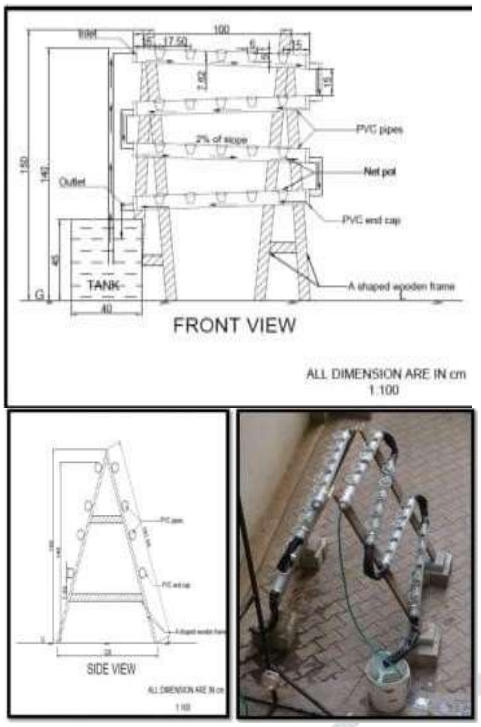
Check the water levels daily; in some regions, it may be necessary to check it twice a day, depending on water loss due to excessive heat and evaporation. Check the pH and nutrient levels every few days. Because the pump runs full time, you don't need a timer, but make sure the tank doesn't dry out or the pump will burn up.

Step 6: Monitor Plant Growth

A few weeks after planting, the plants will completely cover the trellis because they'll have all thewater and nutrients they need to grow quickly. It's important to keep a close eye on plant growth and tie or clip the plant stalks every few days

Figure 4.6 Monitored Plant in Nutrient Film Technique

During the entire process of cultivation of plants in hydroponic system following important valueswere maintained for satisfactory growth of plants.



CALCULATION :

Number of plants = 40

Discharge per plant required = 2 L/min

Total discharge, Q = Number×Discharge per plant

$Q = 40 \times 2$

$Q = 80$ L/min $= 80/(1000 \times 60)$

$Q = 1.33 \times 10^{-3}$ m^3/sec

Discharge height, H = 1.6 m

Specific Gravity, $\gamma = 9.81$ kN/m^3

Power required, $P = \gamma \times Q \times H$

$P = 9.81 \times 1.33 \times 10^{-3} \times 1.6$

$P = 0.0208$ kW = 20.87 Watt

Horse Power =powerrequired/0.735=0.0208/0.735

Horse Power = 0.028 HP

5. CONCLUSION

Taking into account all the above points, benefits and advantages of Hydroponic system over the conventional soil-based irrigation we can conclude that the research carried was truly beneficial as well as it will benefit the society if brought into practice by each and everyone. Also, the research can be taken up as small step towards entrepreneurship.

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