Hydroponic Cultivation (Soilless Farming)

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Abstract -A study has been conducted on the hydroponic cultivation. Today in this 21st century the population is growing at a tremendous rate and thus food production and land for cultivation becoming lesser for increasing population. Also in many rural areas lowering of ground water table is observed which ultimately increases the overall load on food production which further rise problem of food security. Hydroponics is such technique, in which plants are grown with the use of water and nutritional solution only. The nutritional solution contains the essential nutrients which are required for growth of the crops. The crops are artificially supported in the nutrient mixtures and made to grow using the nutrients provided only. So, hydroponics is the system to grow the plants in the most economical manner. Hydroponic is one methodology of soil less cultivation. It is a method of growing plant using mineral nutrients solutions in water, with the use of bouquet sponge. It uses less water than soil cultivation. It saves water a lot. Hydroponic can be used in places where in-ground agriculture or gardening is not possible. Hydroponics may potentially produce much higher crop yields.

Keywords: Hydroponics, soilless cultures, agriculture, drip hydroponic technique, Nutrients

Introduction

Hydroponic farming:

The word hydroponic is derived from the Greek language. Hydro means “water” and phonics means “Labour”. The concept of gardening without soil has actually been around for thousands of years. For example, the Hanging Gardens of Babylon and the Floating Gardens of China are two of the earliest examples of hydroponic gardens. It is a method of growing plants using mineral nutrient solutions, without soil. Terrestrial plants may be grown with their roots in the mineral nutrient solution only or in an inert medium, such as prelate, gravel, or mineral wool. Hydroponics is the technique of growing plants in soil-less condition with their roots immersed in nutrient solution. This system helps to face the challenges of climate change and also helps in production system management for efficient utilization of natural resources and mitigating malnutrition.

Soilless culture is a man-made suggests that of providing plants with support and a reservoir for nutrients and water. In this regards, Saves et al., reported that Soilless culture can be defined as “any method of growing plants without the use of soil as a rooting medium, in which the inorganic nutrients absorbed by the roots are supplied via the irrigation water”. The only and oldest technique for soilless culture may be a vessel of water during which inorganic chemicals melted (nutrient solution) to produce all of the nutrients that plants need. Typically is known as solution culture or water culture. The function of soilless cultivating method is stimulating plant growth while controlling the quantities of water, mineral salts and most important, dissolved oxygen. [6]

The basic concept is quite simple. When roots are suspended in moving water, they absorb food and oxygen rapidly. If the oxygen content is insufficient, plant growth will be slow. But if the solution is saturated with oxygen, plant growth will accelerate. Therefore, the grower’s task is to balance the combination of water, nutrients, and oxygen, with the plan’s needs, in order to maximize yield and quality. For the best results, a few important parameter need to take into account; temperature, humidity and CO2 levels, light intensity, ventilation, pH and the plant’s genetic make-up. However, In Soilless culture plants did not need soil but they need to be supplied with minerals Nitrogen (N), Potassium (K), Phosphorous (P), Calcium (Ca), Magnesium

(Mg), Sulphur (S), Iron (Fe), Manganese (Mn), Copper (Cu), Zinc (Zn), Molybdenum (Mo), Boron (B), Chlorine (Cl) and vitamins also they need water, light, carbon dioxide, oxygen at their root zone. [2]

Different types of hydroponic system: [2]

1. Nutrient Film Technique (NFT):

With NFT hydroponic systems, the nutrient solution is pumped into channels that can hold a varied amount of plants. The channels are slightly sloped, so the nutrient solution flows through the channel, over the plant's roots dangling roots, and back into the hydroponic reservoirDue to the size of the channels, NFT hydroponic systems work best for plants that have a small root system, like leafy greens.

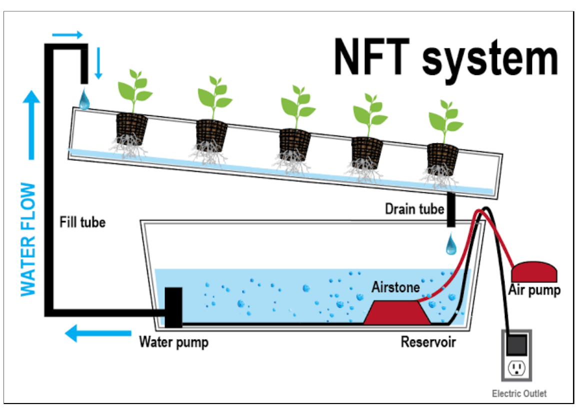

Figure no.1

2. Deep Water Culture (DWC):

With DWC hydroponic systems, the plant's roots are suspended in the nutrient solution and the air is provided directly to the roots with an air stone or diffuser. Plants are placed in net pots with grow medium to help secure them. Because plant is sitting in nutrients and being supplied with unlimited oxygen, they grow like crazy.
Deep water culture works great for almost all plants but works especially well for large plants with big root systems.

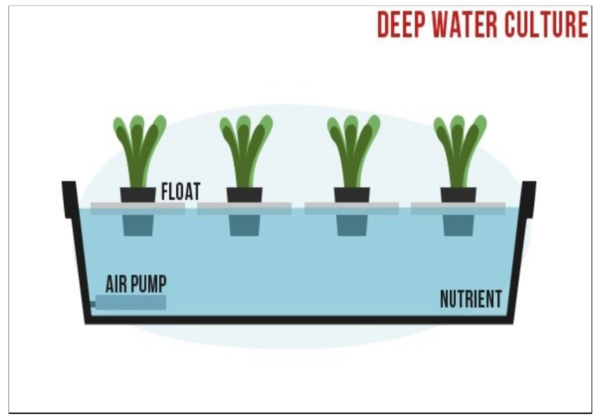

Figure no.2

3. Wick Hydroponics:

The wick system is the most simplistic type of hydroponic system requiring no electricity, pumps, or aerators. Since wick hydroponic systems don't supply the plant with a lot of nutrient solution, these systems only work well for small houseplants and herbs. Plants that don't require much water grow well in wick systems.

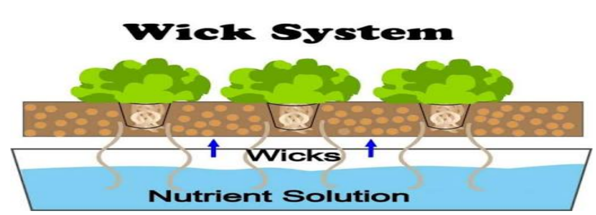

Figure no.3

4. Ebb & Flow/Flood & Drain System:

In ebb and flow systems, plants are placed in large grow beds filled with grow medium. The grow bed is flooded with nutrient solution until it reaches a certain point. A drain allows the

water to only get a few inches below the top of the grow medium, so it doesn't overflow. Power to the water pump is controlled by a timer. After running for a predetermined amount of time, the timer shuts off the pump which allows the water to run back down through the pump, draining the grow bed completely.

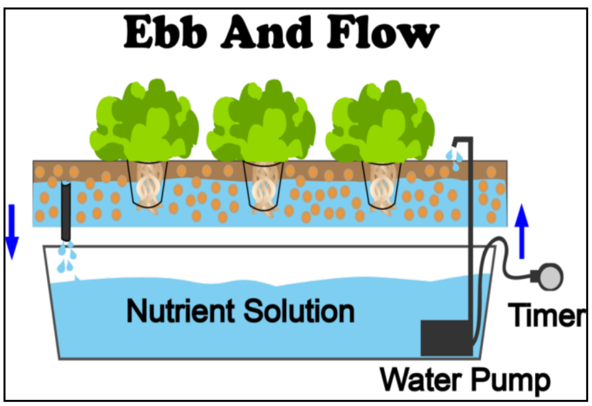

Figure no.4

5. Drip Hydroponics:

Drip hydroponic systems are easy to use, set up, and can be tailored in several ways making it ideal for those who are commonly making changes. With these systems, the nutrient solution is pumped through tubes directly to the base of the plant. At the end of the tubes are drip emitters that allow the nutrient solution to drip at an adjustable flow, saturating the grow medium.

Drip hydroponic systems can be non-circulating or circulating systems. Non circulating systems drip slowly to provide the plant with enough nutrients at a consistent rate. Circulating system drip more often, with excess nutrients flowing back into the reservoir like in the image below.

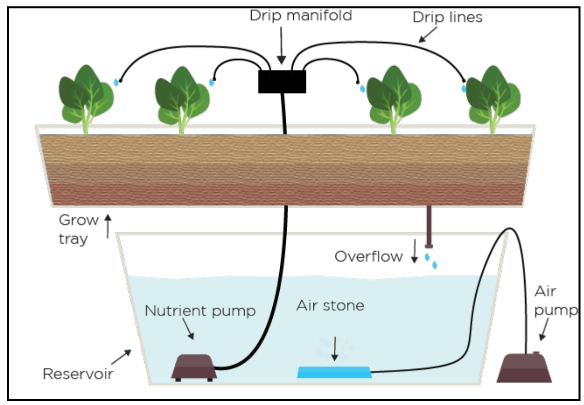

Figure no.5

LITERATURE REVIEW

This chapter discusses the research and work that had been carried out in the past in the field of hydroponics.

John Woodward (1699) published his water culture experiments with spearmint and found that plants in less-pure water sources grew better than plants in distilled water. Mineral nutrient solutions for soilless culture of plants were first perfected in the 1860s by the German botanists, Julius von Sachs and Wilhelm Knops through experiments conducted at1842and 1895 respectively.

Gallegly et al (1949) studied about the bonny best tomato plants were grown in constant – drip sand cultures with concentration 0.1. 0.5, 1, 2 and 8 times that of basal salt solution (Hoagland and Snyder) in cultures with the basal solution low and high in nitrogen, phosphorus and potassium respectively and in cultures with the low phosphorus solution adjusted to low, medium and high pH.

Allen Cooper of England (1960) developed the Nutrient Film Technique. In recent decades, many companies world widely are appearing and strongly working in soilless agriculture. Moreover, NASA has done extensive hydroponics research for their Controlled Ecological Life Support System (CELSS).

NiveditaWaghet al., (2016) they said that, Due to rapid urbanization and industrialization, cultivable land is decreasing rapidly. Due to rising problem of draught, shortage of water has greatly affected Agriculture. Hydroponics is a technique of growing a plant in water with mineral nutrient solution mixed with it in soil less culture with continuous supply of oxygen at room temperature with indirect light. System uses less water and fertilizer as compared to soil system.

He shows how automatic hydroponic system can be implemented using electronic circuit. It describes how the mixture of water and nutrient solution is automatically delivered to the roots of plants. System automatically supplies nutrient into Water every day and regularly re-circulate mixture of water and solution form reservoir. System uses less water and fertilizer as compared to soil system.

Bruce Dunn (2017) define what is hydroponic and discussed about various methods of hydroponic system, like nutrient film technique system, wick system, ebb and flow hydroponic system, deep water culture system, drip system their operation, benefits and limitations, performance of different crops. He discussed about Advantage, disadvantage, limitations, ph control, nutrient solutions, equipments, types of crop, and etc about hydroponic.

Tribhuwan Pant et al., (2018) He said that, the term Hydroponics was derived from the Greek words hydro means water and ponos means labour. It is a method of growing plants using mineral nutrient solutions, without soil. In India, Hydroponics was introduced in year 1946 by an English scientist, W.J. Shalto Duglas. He established a laboratory in Kalimpong area, West Bengal and had written a book on Hydroponics, named as Hydroponics- the Bengal System. Different solutions were suggested by different scientists for growing different vegetables in hydroponics and for different seasons. These recommendations were so complicated that the farmers could not implement it to grow the vegetables in a large scale. Break through attempts were made at Defence Agricultural Research Laboratory now Defence Institute of Bio-Energy Research (DIBER), during late 80s to eliminate the complicacy of growing vegetables without soil and success was achieved by clubbing the soil less cultivation with rain water harvesting technology and developed a suitable nutrient composition.

Nisha Sharma et al., (2019) discussed about 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. 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. 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.

Cesar H.Guzman-valdivia. (2019) He discussed that, the turbulent kinetic energy distribution of the nutrient solution flow in an NFT hydroponic system using CFD. Its main objective is to determine the dynamics of nutrient solution flow when it passes through the channel and around plastic mesh pots. The main contribution of this study is to present a new point of view for determining the ideal nutrient solution flow rate to increase the weight and height of hydroponic crops.

METHODOLOGY

MAKING OF HYDROPONIC CONTAINER

1) In hydroponics, the plant grows in a medium that retains moisture but does not contain nutrients. The medium provides structure for the plants.

2) Start by creating hydroponics containers from the empty plastic bottles having one liter capacity. A set of bottles are used for this experiment. The bottles are cut from the top for use it as a container.

3) The holes are made at the bottom of the bottle so as to drain excess water from the media. The arrangement is made in such a way that the excess water from first bottle is directly drop in the bottle which is kept below it.

4) The remaining excess water from the bottles which are kept below, drop it in a channel constructed at the ground level. The water from the channel is reuse for the watering of plants.

5) For this experiment media used is bouquet sponge. The bouquet sponge is tied with wire at the top of cut bottles to give more space for roots.

CONDUCTING HYDROPONIC EXPERIMENT

1) Seeds of palak and methi were sown in bouquet sponge which is kept in bottles. The seeds are watered with the nutrient Solution.

2) The hydroponic nutrient grow special consist of solution A and B are used. This nutrient contains Nitrogen, Potassium, Phosphorous, Calcium, Magnesium, Sulphur, Iron, Manganese, Copper, Zinc, Molybdenum, Boron, and Chlorine.

3) The nutrients are mixed with water. For one packet of nutrients five hundred milliliter water is mixed. Tap water is used for this experiment.

4) Ten seedlings were planted in each bottle and a set of bottles are used for this experiment. The plants are watered after two days of interval. There is no watering required in each day because bouquet sponge hold the water and it hold the moisture for two days.

5) Thus use of water is controlled and fifty percent of water is required as compared to the plants which are grown in soil. The plants were grown in greenhouse.

Figure No 6

Figure No 7: Hydroponic Growing Substrate Option

DISIRABLE pH RANGE OF NUTRIENT SOLUTIONS

In hydroponic system, pH constantly changing as the plant grows. A change in Ph control is a necessity in hydroponic solutions. The pH range of 5.5 to 6.5 is optimal for the availability of nutrients from most nutrient solutions for most species, but species differ significantly and several can grow well outsides of these range. [9]

ADVANTAGES OF SOILLESS CULTURES:

Production augmentation: The application of soilless culture approximately increases the yields as the result of the precise control of the growth elements to the plants such as nutrition, pH, oxygen, carbon dioxide, light and temperatures. Soilless culture produced vegetables can be of high quality and need little washing.

Water control: In most kinds of soilless culture the uses of irrigation water are accurately controlled with extremely less amount as compared with normal irrigation in the case of traditional soil cultures. It saves much needed labour and time.

Monitor of plant nutrition: The nutrition elements are used as solution forms in accurate amounts as the plant need and not in Hugh amounts as in the normal plantation. PH and E.C. of the nutrient solution can be controlled according to the requirement of the crop and environmental conditions and that is strongly difficult and expensive in the case of normal soil cultures.

Purge practices: Soilless culture is occurred under controlled conditions and that led to avoid spreading of weeds, diseases and insects therefore no need for using the pesticides which finally pollute the environments as used in soil cultures and that mean less labour and less costs.

Monitor root surroundings: In soilless culture, it is easily to control the surrounding environmental and root temperature and supplying roots by oxygen.

Crop diversity: In soilless culture, the interval time between crops is nearly null set because the absence of cultivation operation as in soil cultivation therefore, multiple crops cultivated per year and that mean increasing income.

Agriculture of land inappropriate: Agriculture without soil provides an idealistic process for plant cultivation when there is no appropriate land empty of pathogens and salinity is available.

Alleviation of labour requirements: In soilless culture, all cultural practices of soil cultivation such as soil sterilization, weed control and others can be excluded in soilless culture and that save the labour input and the needed time of work.[4]

DISADVANTAGES OF SOILLESS CULTURES:

High capital investment: The initial cost of building the system of soilless culture is high, but the fast and big yield production offset such costs rapidly in the firstly 3-4 years from the beginning of the system if all things running ok.

The shortage of technicians and skilled labour: Agriculture without soil suffers from a shortage of workers and trained professionals.

The risk of Pathological Injuries: Morbidity in open systems of soilless culture is few whereas in closed systems.

LIMITATIONS OF SOIL-LESS CULTURE:

Despite of many advantages, soil–less culture has some limitations.

Application on commercial scale requires technical knowledge and high initial investment, though returns are high. Considering the high cost, the soil-less culture is limited to high value crops. Great care is required with respect to plant health control. Finally energy inputs are necessary to run the system.[9]

CONCLUSION

As we seen in the results, the plants grow in hydroponics system has more growth rate as compared to the plants grow in soil.

Also hydroponics system requires less water than the plants required in soil.

SCOPE

Hydroponics is the fastest growing sector of agriculture, and it could very well dominate food production in the future. As population increases and arable land declines due to poor land management, people will turn to new technologies like hydroponics and aeroponics to create additional channels of crop production. To get a glimpse of the future of hydroponics, we need only to examine some of the early adopters of this science. In Tokyo, land is extremely valuable due to the surging population. To feed the citizens while preserving valuable land mass, the country has turned to hydroponic rice production. The rice is harvested in underground vaults without the use of soil. Because the environment is perfectly controlled, four cycles of harvest can be performed annually, instead of the traditional single harvest.

Hydroponics techniques produce a yield 1,000 times greater than the same sized area of land could produce annually. Best of all, the process is completely automated, controlled by robots using an assembly line-type system, such as those used in manufacturing plants. The shipping containers are then transported throughout the country.

There has already been a great deal of buzz throughout the scientific community for the potential to use hydroponics in third world countries, where water supplies are limited. Though the upfront capital costs of setting up hydroponics systems is currently a barrier but in the long-run, as with all technology, costs will decline, making this option much more feasible. Hydroponics has the ability to feed millions.

Hydroponics also will be important to the future of the space program. NASA has extensive hydroponics research plans in place, which will benefit current space exploration, as well as future, long-term colonization of Mars or the Moon. As we haven't yet found soil that can support life in space, and the logistics of transporting soil via the space shuttles seems impractical, hydroponics could be key to the future of space exploration. The benefits of hydroponics in space are twofold: It offers the potential for a larger variety of food, and it provides a biological aspect, called a bio-regenerative life support system. This simply means that as the plants grow, they will absorb carbon dioxide and stale air and provide renewed oxygen through the plant's natural growing process. This is important for long-range habitation of both the space stations and other planets.

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