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A Review on Hydroponics: A Sustainable Approach for Plant Cultivation

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Abstract

Sustainable development is really a matter of concern now days. Many natural events prove that Earth is reaching nearby its threshold limit in terms of natural resources. Saving is natural resources with maintaining rate of development for any country is a major challenge. Especially in case of agriculture, rate of utilization of land area and water consumption is really high. Some effort towards modification in traditional methods of plant cultivation is essential but with rise in total plant productivity or without affecting previous rate of productivity is required. Hydroponics, a novel or non popular plant cultivation technique is showing some assurance towards sustainable development. Hydroponics is a method of plant cultivation without soil. Amount of water requirement is really very less as compared to soil based technique. Some of the plant species is very much compatible for hydroponic cultivation. They include mostly herbaceous or plants with small morphology. An earlier report proves that the existence of hydroponic for plant cultivation in all the seven continents of the world map. Which indicates that world is ready to adopt modification and novel approaches over traditional method of plant cultivation.

1. Introduction

Water is souvenir from the nature to us. Existence of all life kind depends upon water prosperity of the Earth. Consumption level may vary from species to species among all living organism but this cannot elucidate importance water in their life. All life forms including unicellular to multicellular organisms is composed of water as a major part in their total cadaver. Life cycle of higher organism like humans and plants are extensively affected by availability of water type for their use. A well known fact that everyday rise in human population is directly compelling us to thing about food scarcity and food security. We are well aware that food resources are the major concern for the existence of mass population. Existence of human population also affects almost all other living species directly and indirectly in food web, but without continuous supply of useable water resources and food, there is a threat of mass destruction. Now, there is a need to find out some new ideas and creative work out that can help to ensure existence of living beings for longer time with available and limited resources, specially water and food.

Agriculture provides us a major part of food and energy resources. This is followed by dairy and animal farming in well support. But question is **"what are the basic needs in agriculture?"** Yes, the answer is Sunlight, Water and Nutrition. Apart from sunlight, water also helps in transportation of various mineral and ions from soil to plant body. It means supply of nutrition also depends upon water flow from outside plant cell to inside. If, importance of water is significant and only limited resources are available with us then it's certainly a matter of discussion. Because limited water resources and rate of consumption and pollution in water body is hospitable for upcoming troubles.

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Hence, there is a need of collaborative effort to avoid water scarcity for future generation and sustainable of use of water in our life. A simple and effective technique that is capable to support and enhance total agriculture productive is discussed in this article. The technique is known as "**Hydroponics**". Hydroponics is a technique that can help us to limit or minimize the consumption of water for cultivating plants. It is scientifically proven that only 2% of total supplied water is utilized by the plants in outdoor conditions.

In last few decades contribution of plant tissue culture technique and genetic engineering is also significant. **Plant tissue culture** is a technique in which *in-vitro* plant cultivation is done by the professionals. Plant growth is partially maintained under artificial climatic conditions in the beginning of plant growth after that they are transferred to green house facility for more adaptation toward natural climate. Actually purpose and aim of the tissue culture is totally different than the Hydroponics. Plant tissue culture is associated with the major aim of saving endangered species of plant and production of genetically modified plant (GMP) with the help of genetic engineering. On the other hand hydroponics is a simple plant growing technique with the aim of increasing gross productivity of crops. Hence we can say there is no comparison between plant tissue culture and hydroponics because their aim and applications are different from each other weather both techniques helps to rise or grow plant. Moreover plant tissue culture technique is very close to scientific approach and more effective with use of scientific equipments. Popularity of hydroponics depends upon its simplicity and cost effectiveness. It means principle aim of hydroponics is low investment and high output that can result into rise in gross productivity of crop varieties by the farmers and peoples as well.

2. Types of Hydroponics

Wick System: An absorbent matter like perlite or vermiculite and wicks made up of nylon are used to place seed/plant into the nutrient medium. This type of hydroponic system only includes pumps, aerators, absorbents and support system.

Water Culture: In this type of hydroponic system roots are completely submerged in nutrient solution. It is very simple to assemble and use.

Ebb and Flow: This system is consists of growing medium like rockwool or perlite. Plant roots are supported by growing medium bed socked with nutrient solution. A pump is used to maintain regular flow of nutrient solution toward growing bed. There is a need of maintenance of consistency and level of nutrient solution at regular interval.

Drip System: Drip system requires a drip emitter to regulate flow of nutrient solution toward plant root at a particular time interval. This system allow us to regulate flow of nutrient solution according to the requirement of nutrient by different plant species.

Nutrient Film Technique: The nutrient film technique system is widely accepted for growing plants hydroponically. A separate reservoir of nutrient solution is provided with this system, which is used to circulate nutrient solution medium continuously with the help of pump. A large channel of plant growing bed is nourished through a single large source of nutrient reservoir. This method avoids cluttering of various essential and non essential nutrition components.

Aeroponic system: A continuous spray of nutrient medium has been maintained through the nozzles positioned nearby the plants. The main target of spraying nutrients is root, from where nutrients are readily absorbed by the plants. Pressure and rate of flow of flow of nutrient from the nozzle is regulated according to the need and type of plant root.

Kratky method: Kratky method involves a simple placement of seed/plant into the nutrient reservoir with the help of some support. There is no need of pump, aerator and any other electrical equipment. Once root has been generated, it will extend itself toward the depth of nutrient medium. A small air gap has been provided between nutrient solution and plant body that will help roots to breathe.

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3. Methodology

Basic requirement of hydroponics are listed below -

Liquid nutrient: Nutrients are composed of various micro and macro elements based on their requirement by the plants. Micro elements are required in small quantity, which is usually measured in micrograms. Requirement and consumption of macro elements can be measured in grams or higher amount. We must remember that both are equally important for the normal growth of plant body and its part. Nitrogen, phosphorus and potassium are very essential elements and categorized under macro elements.

Solid support: Solid support system is the replacement of soil. This is the significant characteristic of hydroponics **"a soil less plant cultivation"**. Solid support system only helps to hold plant body and providing liquid nutrient medium to root of the plant from where nutrients are absorbed and utilized by the plant for its normal growth.

Aerator or pump: Aerator or pump is a mechanized instrument that helps in two different ways. Firstly it helps to maintain or increase dissolved oxygen and other gases and secondly it also helps to sustain uniform distribution of dissolved nutrients and elements in liquid nutrient medium.

Controlling and measuring devices: Controlling temperature under indoor plant cultivation is good for achieving high gross productivity, if provided by cultivators. Temperature around 30-35°C is optimum in case of many crop plant species but it may vary ± 10°C in case of certain plant species too. High humidity around 70 % to 80 % is also beneficial for most plant varieties. Humidity measuring and maintaining devices are also helpful for obtaining optimum growth of plant. Last but not the least pH meter is also very important device that can be useful to maintain pH of liquid nutrient medium. Change in pH indicates that consumption of essential elements is done by the plant and more nutrients are required for more growth. pH is also important for absorption, transportation and metabolic activities of plant cell. Hence pH of liquid medium can also affects the growth of plant body. Check and maintenance of pH at regular interval is necessary.

ADVANTAGES OF HYDROPONICS

- Sustainable use of water, especially minimizing amount of water used for irrigation of plant in agriculture.
- It also provides opportunity to control over climatic conditions like temperature, light intensity and time duration, humidity etc.
- No use of pesticide, weedicides and harmful chemicals, used by farmer in outdoor agriculture technique. Hence, there is no water and soil pollution. Even bioaccumulation of such harmful compounds affects whole food chain or food web.
- Soil and water born diseases are also absent in hydroponic system. Sterilized or clean water is used to prepare nutrient supply.
- Climatic changes cannot alter plant growth if plants are cultivated in indoor hydroponic system, which is preferred mostly.
- Soil fertility is not a matter of concern in case of Hydroponic system.
- Total gross as well as net productivity is always high as compared to soil because loss of plant and its product due to climatic behavior and biological stress can be minimized or stop.

LIMITATIONS OF HYDROPONICS

Nothing is perfect in this world. Hence, this technique also has its own limitations that can be minimized with some scientific approaches too. Some of the limitations are listed below -

- Initial setup requires some sort of scientific approach and skill.
- Hydroponical setup is more compatible with small sized herbaceous or some sort of shrub plant species. It is very difficult to cope up with large size plant and trees in hydroponic system for various reasons like size, per unit cost of setup, solid support system etc.
- Initial setup may require significant economic support if we use latest scientific equipments for providing control over climatic conditions to achieve maximum productivity.

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- This technique cannot replace traditional method of agriculture; it provides only option to increase or rise in total percent productivity.

EXPECTATIONS FROM HYDROPONICS

- We can bring rise to total mass productivity of any country.
- Indoor plant cultivation and green evolution will bring healthy atmosphere around us.
- Small herbaceous plant of various uses like vegetable and herbs will bring economical support.
- It will reduce soil pollution caused by use of pesticide, weedicide and other harmful chemicals.
- Non biodegradable waste material like plastic bottles, buckets, pipes can be used for establishment of hydroponic system.
- Working with easy and novel agriculture technique will increase awareness and environmental education among the people.

4. Discussion and Conclusion

Many regions in world map is facing water scarcity and soon this trouble will cover a major part of world too. Some creative and novel approaches like Hydroponics can ensure availability of useable form of water for human use in future. This technique cannot stop use of water for plant cultivation but it can minimize the use of water for growing plant. Hydroponic is not a replacement of traditional agriculture method but it is supportive or an additional technique that can be useful for increasing annual productivity of any state, country or at global level. Morphology of plant is a very important factor for choosing type of hydroponic system. Especially in case of root structure and type. Fibrous and taproot system is expected to select plant species as well as length of shoot and branch system is also important. Herbaceous species are very much friendlier for hydroponic system because they are small in size and easy to handle. As the height and weight of plant body increases, it will also need strong support to hold them. On the other hand big size plants need more space for their expansion. Hydroponic system is mainly concerns with indoor plant cultivation and big sized plant may be unsuitable for indoor facility.

Use of technology depends upon the individual's capability and budget. Use of basic electronic equipments like thermometer, pump, sprayer, drip emitter and pH meter are cheap and easy to use. There is no need of professional guidance and certification for their use. But these small equipments can strengthen the total productivity and healthy plant culture. Moreover they are cheaper than the heavy machines used for irrigation and plant cultivation in traditional methods. Actually this plant growing technique could be classified between beginners and professionals. Literature reveals that hand on practice sparkles with the time and enhances our precision in any field of science and technology. In the end we can conclude that each and every approach towards the food security is important for our future safety. Expectation is very high with this novel technique of Hydroponics. But we should also keep in mind that hydroponic cannot replace the traditional method of plant cultivation. It is simply a supportive method that can increase gross productivity of vegetable, fruits and flower.

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