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Hydroponics: A System to Study Nutrient Availability and Plant Responses

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ABSTRACT

Any method in which plants are grown without using soil as a rooting media and essential nutrients can be supplied through irrigation water is said to be soilless culture. Hydroponics is one of the soilless culture systems. The fertilizers (containing nutrients) are supplied by dissolving in the irrigation water in appropriate amount. Growing plants using different nutrient-rich water has been practiced for centuries. There are different techniques used to grow plants hydroponically. In hydroponics system, all the essential plant nutrients are provided via the nutrient solution. Hydroponics can play a great role in cultivating plants especially in urban areas where very limited space is available. The use of a hydroponic growth system is most advantageous in situations where the nutrient media need to be well controlled and when intact roots need to be harvested for downstream applications. Nutrient concentrations can be modified to induce plant responses to both essential nutrients and toxic non-essential elements.

INTRODUCTION

Considering that human world population will reach about 9 billion by the year 2050, it appears clear that food security is one of the pivotal themes of the new millennium and, reasonably, the most urgent challenge for the agricultural sector. However, it should be considered that the progressive drop of fertile soil surface, due to environmental pollution and urbanization phenomena will greatly complicates the context. In this regard, the intensification of the production cycles and the monoculture approach, which favored the diffusion of many pathogens and the development of the corresponding pathologies, should also be taken into account. Moreover, the strict dependency of agricultural practice on water availability in an age of drastic climate changes (desertification) makes the scenario even more complex. In this respect, the possibility of exploiting surfaces not anymore fertile (due to pollution or pathogen problems) for agricultural purposes and also limiting at the same time the water consumption makes the soilless system cultivation surely a valid opportunity. Moreover, it should be highlighted that this cultivation approach also represents a favorable response toward a more environmentally friendly agriculture as well as a promising tool also in the vision of the general challenge of food security.

Figure 1 Hydroponic Farming

Hydroponic Farming

In the simplest terms, Hydroponic Farming can be defined as a form of soil-less gardening. The process involves growing a bunch of healthy plants without using soil. Here, the soil is substituted by an alternative nutrient like water. So, all plant needs are proper water and sunlight to thrive. The process is quite simple and since the soil is not involved here, it is also low-maintenance and hassle-free.

Advantages of Hydroponic Farming:

The possibility of Hydroponic farming with a couple of benefits to achieve:

1. **No Soil Involved:**

Since Hydroponic farming involves growing crops without soil, it is an ideal option with limited accessibility of land. During the mid-nineties, Hydroponics was used for supplying fresh crops to the troops in the distant Wake Islands. For the uninitiated, the Wake Islands is a distant arable area located in the Pacific Ocean. In recent years, Hydroponic is often deemed as the farming method of the future as several astronauts in NASA have considered this possibility for growing crops in the space.

2. Optimal Use of Location:

The requirement of the plant is provided for and duly maintained in a structured system, Hydroponic Farming can be performed anywhere. In a space-crunched apartment, Hydroponic Farming where the plants will be grown in bedroom or balcony.

When it comes to conventional farming, the plant roots expand and thoroughly spread out in a bid to search for food and oxygen levels in the soil. However, such is not the case with Hydroponics.
Here, the roots are already submerged in a tank of oxygenated solution that has direct contact with the vital minerals. That means multiple plants can be grown in proximity without having to worry about space.

Figure 2 Benefits of Hydroponic Farming

3. Complete Control over Climate:

As with greenhouses, hydroponic growers have absolute control over the climate. They can adjust the temperature, the intensification of light, and the humidity levels as per requirements. In Hydroponic Farming one can continue growing crops all year round without having to worry about the season. This is also likely to boost the business profits of farmers.

4. Saves Water:

The plants grown in a Hydroponic system barely use around 10% of the water when compared to the conventionally field-grown plants. The water used here is drastically less because unlike conventional farming water is reused or re-circulated. Plants take in their required water, while the excess water is captured and trapped back in the system. Water loss, therefore, occurs only through two pertinent forms: evaporation and system leaks. With that being said, an efficient Hydroponic setup will minimize leaks or won't have it in the first place.

It is assumed that agriculture involves only 80% of groundwater and surface water in the United States. Since water is already becoming a critical issue amid the growing need for food production, Hydroponics is deemed to be an excellent solution for addressing this issue.

Figure 3 Layout of Hydroponic Farming

5. Optimal use of Nutrients:

When it comes to Hydroponics Systems, there is absolute control over the nutrients as required by the plants. Even before proceeding with the farming, kind of nutrients and plants requirement can be checked and mix particular amounts of those nutrients with water at different stages. Since the nutrients are duly conserved in tanks, there is no possibility of nutrient loss.

Figure 4 Hydroponically grown tomatoes

6. pH Control:

Since every mineral is directly in touch with water and manually adjust the pH level as and when required. This will ensure that the plants receive optimal nutrient intake.

7. Faster Growth Rate:

Another major benefit of the Hydroponic system is that it ensures a faster growth rate and have entirely in control over the environment required for the plants' growth. That means the control over every parameter like the temperature, the surrounding light, moisture, and most importantly, the nutrients. The plants will be placed in an ideal condition and nutrients will be sufficiently provided where they can directly contact the root system. This way, plants won't waste their valuable energy looking for diluted nutrients submerged deep within the soil; rather, they can almost entirely be focused on thriving and boosting the production of fruits.

8. Zero Weed:

In conventional gardening (with soil) probably familiar with how irksome weeds can get. Trimming weeds is one of the most exhausting tasks for crop owners or gardeners. With tilling, plowing, and hoeing, the process practically seems endless. Since weed is entirely associated with soil, when it comes to soilless hydroponic farming, one won't have to bear the trouble of dealing with weeds anymore.

9. Fewer Pests and Ailments:

As with weeds, removing soil ensures that plants are not as susceptible to soil-borne pests like gophers, groundhogs, or a bunch of birds .Plants can be protected from ailments like Fusarium and Rhizoctonia. Since Hydroponic Farming involves growing plants in an entirely closed system, the gardener has entire control over the related variables.

10. Fewer Insect ides and Herbicides Involved:

Since Hydroponic Farming doesn't involve any soil, the process also eliminates the need and use of chemicals. Over the time, this enables to grow clean and healthy foods and safety is kept at priority and never compromised on at any point.

11. Time-saving Process:

Besides spending significantly less time over tilling and cultivating plants and getting rid of weeds, to witness quicker and less-time intensive plant growth in Hydroponic farming. Every time agriculture is designed with a space of technology, Hydroponic Farming fits right in.

12. Relieves Stress:

As with any other form of farming, Hydroponic Farming is one of the most stress-relieving hobbies. It gives one rare chance to reconnect with nature.

So, when worked up after a tedious day at the office ,it is always come back home to little Hydroponic garden where plants rear and grow from scratch.In the beginning, proceed with fresh and delicious veggies and then proceed to move forward to herbs and fruits. Either way, the process is incredibly relaxing and it adds just the right dose of freshness to the small little space.

Disadvantages with Hydroponic Farming:

As with any method of farming, Hydroponics comes with its own set of cons. There are some of the disadvantages of hydroponic farming:

Figure 5 Plant roots without soil

1. **Time Consuming:**

While the process of Hydroponic Farming might seems feasible and convenient, it is slightly time-consuming as well. The plants thriving in soil may be ignored for days or even weeks as both nature and soil perfectly balances everything. However, such is not the case with Hydroponics.
Since the plants growing in this process almost entirely thrive on water, to be gentler with them. The water needs to be replaced at regular intervals, and needs continuous check on the plants to see if they are doing just fine.

2. **Requires some Expertise:**

The process of Hydroponic farming depends on a range of equipments that requires proper expertise. Unless to know how to operate the equipments, the plants won't thrive or flourish as much as per their development seems to be. Even the minute mistake can affect the plant growth almost entirely destroying the Hydroponic System. That is why it is extremely important to familiarize with the equipments and techniques involved in this process of farming.

3. **Risks of Water and Electricity:**

Two major factors in Hydroponic farming are electricity and water. So, unless with adequate water or stable electricity, the Hydroponic system won't thrive well. While growing plants in this system, needs to ensure proper safety precautions so that the plant growth isn't affected at any stage.

4. **Treats of System Failure:**

While using electricity for managing entire Hydroponic system that needs to take precautionary measures during the event of power blackouts or dim-outs.

Since the system won't operate due to the lack of electricity supply, thereby drying out the plants it is extremely important to take this precaution even before proceed to move forward with a Hydroponic system.

5. **Debates over the Organic Nature:**

Over the last couple of years, there has been significant debate and deliberation on whether Hydroponic Farming is indeed a certified method of organic farming. Many farmers have questioned whether plants grown through Hydroponic farming can be indeed certified as Organic as they do not receive the micro biomes as available in the soil. However, people across the globe have produced Hydroponic plants like tomatoes, lettuces, and other leafy vegetables over the last decade. Countries like Australia, the US, and the Netherlands have already performed and succeeded in this mode of farming. At the end of the day, it has produced food for several thousands of people. It is worth noting here that expecting any method of farming to be perfect. Even if the plants are growing in soil, there will be risks of pests and pesticides when compared to Hydroponics. That is why certain organic farming methods are suggested for Hydroponic farmers as well. For instance, certain growers provide the required Micro biomes to the plants by using organic growing artifacts like coco coir or worm casting. Alternatively, natural nutrients like fish, cottonseeds, bones, or even alfalfas may be used in this process.

6. **Expensive:**

Unlike conventional soil-based farming, Hydroponic Farming involves expensive equipment (at least for the first installation). Regardless of the kind of system, plan to build will require containers, high-quality lighting, an accurate timer, and quality nutrients. After finally setting up the system, the recurring cost will only be limited to the nutrients and the electricity, if willing to shell-out a heavy initial expense, this may not be the best option.

7. **Return on Investment:**

If already keep up with the updates regarding agricultural start-ups and probably familiar with the costs involved in Hydroponic Farming. It is important to note that Hydroponics is an excellent advancement when it comes to the agricultural sector. However, if plan to perform this farming on a large, commercial scale, the return on investment won't be as high. That is primarily because of

heavy initial expenses and the unsteady profits. As of now, it is not very convenient to come up with a proper, profitable plan to urge farmers in trying Hydroponic farming commercially.
Overall, Hydroponic Farming is an excellent method of farming and its benefits often outweigh the cons. Since now familiar with the pros and cons of Hydroponic farming, consider giving this novel method of farming a try. Given the many benefits it comes with, the process will certainly meet and exceed as per expectations.

CONCLUSION

It is clear that it has been possible to grow plants without soil completely and hence leads to more quality, improved and more nutritious plant growth with the help of designed hydroponic system. By providing artificial light, it supplements to the excessive amount of sunlight that the plants can get for fully grown height and can contribute to environment friendly. Hence we can conclude that hydroponics is the future of farming. Agriculture is the developing industry of our country which is expected to grow rapidly in future as well. Hydroponics is the alternative farming method which does not require soil or wide space. Hydroponic cultivation of plants is better than traditional methods of cultivation. It can play a great role in cultivating plants especially in urban areas where very limited space is available. Training should be provided to the farmers for growing plants using Hydroponics system. Agriculture universities and research institution should be given funds to perform survey and try to develop new techniques which are cost effective.

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