International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395-0056
Volume: 08 Issue: 06 | June 2021 www.irjet.net p-ISSN: 2395-0072

A Research on Hydroponics – Growing Plants without Soil

Sourabh Ramakrishna[1]

[1]*Electronics and Communication Engineer, Mysuru, Karnataka, India*

Abstract - *Hydroponics is a divaricate of hydro-culture, a method of growing plants without the help of soil by using mineral nutrient solutions instead of water solvent. Earthbound plants possibly grown only with the roots exposed to a nutrient liquid or the roots may be physically covered by a static medium material such as perlite, gravel or other substrates. Hydroponic technology is now becoming increasingly extensive all over the world due to the high-yielding assets of the executives and the production of quality food. Soil-based agriculture is currently facing a variety of taunt, such as urbanization, cataclysmic occurrence, environmental change, intermittent use of synthetic substances and pesticides that drain land yields. This research enfolds a characteristic part of the hydroponics, plants developed within the hydroponics structure and the global market for hydroponics. This research debates the various types of hydroponics; which includes types of substrates and sanitization methods required for the recycling of substrates.*

Key Words: Hydroponics, substrates, nutrients, sanitization methods, drawbacks of existing system.

1. INTRODUCTION

1.1 WHAT IS HYDROPONICS?

Hydroponics is a method of growing certain plants and vegetables without soil but with the help of solution composed of nutrients in water solvents.

1.2 PURPOSE OF HYDROPONICS

The aim of this paper, presented a vision of agricultural programs that can be done without land. However, landless agriculture provides a way to control the shortfall of the normal amount of water needed to grow crops. There are a variety of outdoor farming methods that seemed to be used recently. Soilless farming can be done in a diversity of domain such as balconies, roofs and uncultivated lands. These types of agriculture work under decisive conditions in order to obtain high yields and high incomes. Whilst there is an increase in the current cost of landless cultures, the quantity of production banishes this amount in a very short period of time.

If a right hydroponic system is built and the water is maintained free from impurities, the growth rate can increase up to the rate 30 percent faster than soil-based planting methods. There are seven separate types of hydroponic systems, which include the following:

WICK SYSTEM: It is the simplest type of hydroponic system, to grow plants as it can be developed by anyone practically. The wick system is outstanding for not using aerators, pumps or electricity. It is the only hydroponic system that doesn't need the use of electricity. With the preponderance of wick systems, the plants are placed directly within an absorbent substance like perlite or vermiculite. In nylon wicks, it is positioned in a such way that the nylon wraps around the plants first; before being sent straight down into the nutrient solution.

One major drawback of wick hydroponic system to grow plants; this system is unable to obtain a significant amount of nutrients to the plants. This system is ideal for portable garden plants and herbs. Any plant that doesn't require a fundamental amount of water will grow well in this specific system. While this system is fantastic for smaller plants, we need to avoid growing plants like peppers and tomatoes; these mentioned plants are considered to be heavy-feeding plants, which means that they require more nutrients than the wick system will be able to contribute. Another negative aspect of this growing system is that water and nutrients aren't absorbed evenly, which could lead to the build-up of toxic mineral salts. When using this system, we need to make sure that we flush any extra nutrients with fresh water every 1-2 weeks.

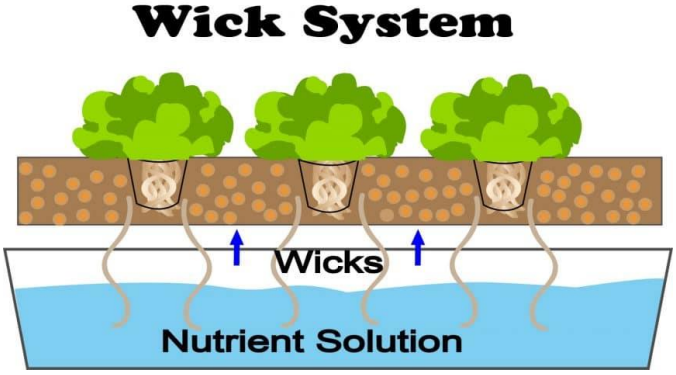

Fig 1. Wick System

DEEP-WATER CULTURE SYSTEM: It is an oversimplified type of hydroponic system that places the roots of the plant directly into the nutrient solution. When compared to the wick system, it places certain materials between the plants and the water but the water culture system bypasses this barrier. The oxygen that the plants required to survive is dispatched into the water by a diffuser or air stone. While using this system, the plants should be secured into a proper position with net pots.

The best aspect of the deep-water culture system is that the plant roots are placed straight into the nutrient system, in a

way that the nutrients can be easily absorbed by the plants. Because of the direct access to nutrients and oxygen, plants which are grown with the deep-water culture method will grow very quickly. The best aspects of the deep-water culture system are that it's very easy to make and works well with any kind of plant. Even substantial plants with considerable foot systems will grow rapidly with this method. There is one significant issue with this hydroponic system is the spread of root diseases, which is caused by dirty growing conditions.

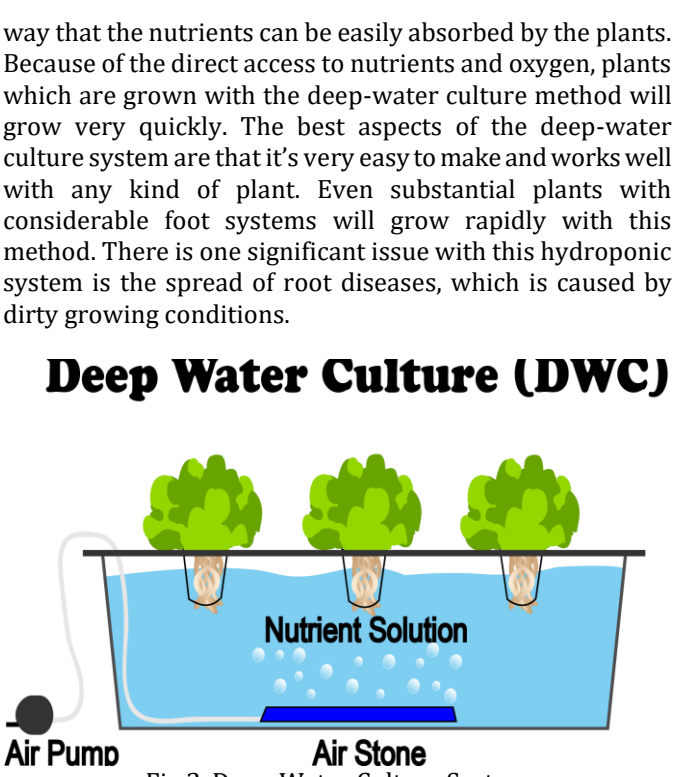

Fig 2. Deep-Water Culture System

EBB AND FLOW SYSTEM: It is a highly popular hydroponic system that is mainly focused among home gardeners. In this system, the plants are arranged in a spacious grow bed that is packed with a grow medium like rockwool or perlite. When the plants are gently planted, the grow bed will be immersed with a nutrient-rich solution until the water gains a couple inches below the top layer of the grow medium, which secures the solution from flooding.

The water pump that floods the grow bed is equipped with a timer; which closes the valve of the pump after a certain amount of time. When this takes place, the water will be drained from the grow bed and dispatch back into the pump. This system has turned to be effective at growing almost all types of plants, which incorporates certain root vegetables such as carrots and radishes. Nevertheless, this system does not recommend to trial out large plants. Because, the amount of space required by these plants may not be able to fit with the grow bed among larger plants. The main drawback of this system is that the pump controller can malfunction, which interrupts the operation until the pump is fixed or replaced.

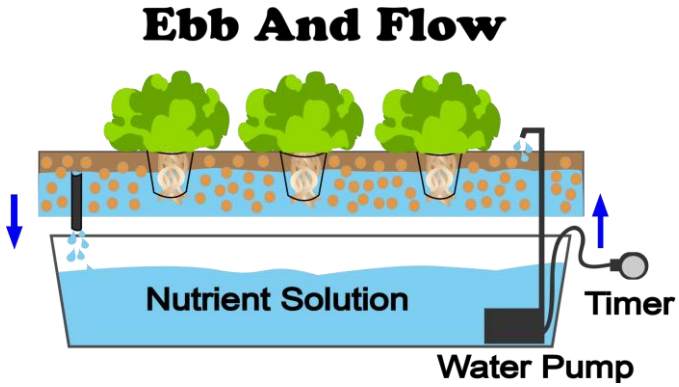

Fig 3. EBB and Flow System

DRIP SYSTEM: It is an easy-to-use hydroponic system that can be rapidly altered for different types of plants, which makes this a great system for any grower who plans to make regular changes. The nutrient solution which is used in this system is pumped into a tube that sends the solution straight to the plant foundation. At the tip of each tube, there is a drip emitter which controls the amount of solution required by the plant; the flow can be adjusted to meet the criteria of each individual plant.

In this system the size can be small or large; it can also be circulating or non-circulating system depending upon the user requirements. A circulating system will drip almost persistently. Additional nutrients will be restored back into the tank that holds the nutrient solution. Although this system can be altered into any size and flow rate, hence any plant can be grown. When using a circulating system, the main issue is to consistently maintain the fluctuating nutrient and pH levels that occur when the solution is recirculated.

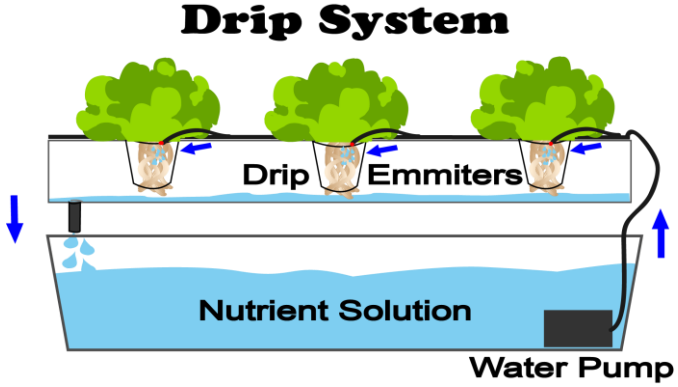

Fig 4. Drip System

NUTRIENT FILM TECHNIQUE SYSTEM: It is a simple design and widely used due to the variety of different applications. When using this system, the nutrient solution is placed into a large container. The nutrient solution is pumped from the container with the help of water pump. The nutrient solution, flows through the sloped channel and over the roots of each plant to provide the right amount of nutrients. With the help of sloped design, it allows the excess nutrients to flow back into the container.

It is highly recommended to use net pots with this system. In most instance, this system does not make use of a grow medium. Since the channels that are used in this system are comparatively small, it is recommended to grow plants that have smaller roots.

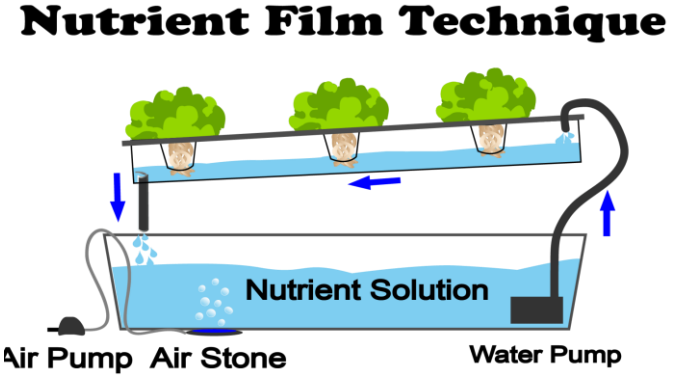

Fig 5. Nutrient Film Technique System

AEROPONIC SYSTEM: In this type of system, the root of the plants will be suspended in air. Numerous mist nozzles are positioned below the roots of the plants. This system has proven to be effective when compared to other hydroponic systems due to the nozzles which sprays the nutrient solution directly onto the roots of each plant. The mist nozzles are directly connected to the water pump. The excess solution sprayed from the mist nozzles will flow back into the container.

If right dimensions of the container are built, all varieties of plants can be grown. To grow larger plants the container should be very deep. Or else, mist nozzles cannot be able to reach all of the roots. The plants in this system are suspended in air, which gets enough supply of oxygen. This system considerably, absorb less water than any other hydroponic system. The complication of this system, that it is expensive to build and the nozzles can be clogged over the time, which can be frustrating to clean.

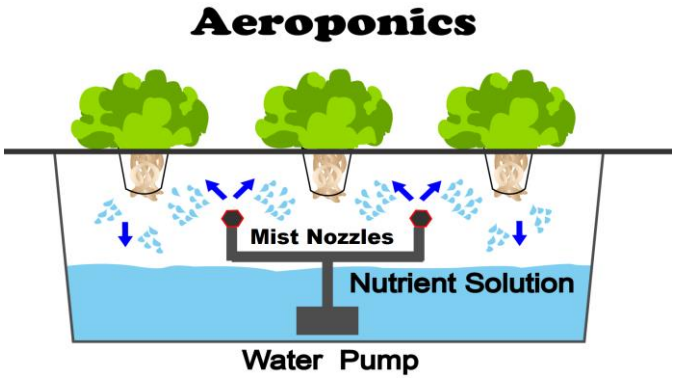

Fig 6. Aeroponic System

AQUAPONICS SYSTEM: It is an aquaculture system, where aquatic animals such as snails, fish or prawns are raised in a reservoir by a combination of hydroponics where plants are grown in a mutual environment. The water from the reservoir goes to the grow tray with the help of pump, where the poisonous substance is lowered by Nitrifying bacteria that reside on the surface of the beds that grow first into nitrites and later nitrates. These nitrates are used by plants as nutrients and then purified water is sent back to the reservoir. Although, the water used in this system goes through the biofilter area where Nitrification bacteria can spread and transform ammonia into nitrate, which is used by plants. The complication of this system is increase in toxins based on ammonia base as toxic products for aquatic animals, which may lead to death of aquatic animals. Hence it has to be cleaned and maintained from the toxic substance. The major three types of aquaponics system are:

- Media-filled beds
- Nutrient Film Technique (NFT)
- Deep Water Culture (DWC)

2. NUTRIENTS USED IN HYDROPONICS

In a hydroponic system, plants require nitrogen, phosphorous, potassium (N-P-K) and various trace elements to grow. Hydroponic nutrients are mainly in solution form of N-P-K with subordinate nutrients and macro elements such as trace minerals in various quantities. The subordinate nutrients are typically varying degrees of sulphur, calcium and magnesium. The nutrient solutions are mixed with water in a container and applied to the plant's root system over and over in a day. Some hydroponic nutrients do come in powder form, but the majority of hydroponic nutrients are in solution form.

The nutrients use substrates as foundation for moisture retention which includes rockwool, perlite, clay pellets or coir/coco. Hydroponic nutrients are sold in multi-part bottles, one for growth and one for florescence. Because plants require different amounts of different nutrients throughout their growth revolution. Hence, a grower is able to understand crop's nutritional needs in order to achieve maximize yields.

3. SUBSTRATE USED IN HYDROPONICS

In a hydroponic system, plants are directly grown in a water-based, nutrient-enriched solution. As there is no requirement for soil, plants do require support for their roots and to improve moisture retention. So hydroponic substrates are used as support for this purpose. There are mainly four types of substrates used in hydroponics, whilst there are multiple options past these four.

1. Rockwool: It is one of the most familiar substrates available in the market. It is made from natural stone, which has been melted and then revolve into filaments. It works with almost variety of hydroponic systems and can be used with plants of any type or size.
2. Perlite and Vermiculite: Perlite is made from igneous rock; vermiculite is made from mica. Both are affordable and work well with wick system.

Although, they are lightweight and are superior for new plants (seeds or cuttings).

3. Clay pellets: Also known as Grow rocks, Clay pebbles, Hydro ton or LECA. It works well for the systems where watering is constant, but do not hold on too much water.
4. Coir/Coco: It is made from coconut husks and can be purchased as blocks or bricks. It offers good water retention and it is completely biodegradable.

Additional options on the market include peat moss, sawdust, sand and gravel. The above four listed are the most commonly used.

4. ADVANTAGES AND DISADVANTAGES OF HYDROPONICS

Advantages:

- It consumes less water when compared to soil based growing technique.
- Plants can be grown anywhere (i.e., home, field or any free space).
- Seasonal plants can be grown in any season.
- It is prone to fewer pest problems.
- It has improved growth and yield.
- It has higher plant density.

Disadvantages:

- It requires constant maintenance and monitoring.
- It can be vulnerable to waterborne diseases.
- It is vulnerable to power breakdown.
- It is expensive to set up.

5. CONCLUSION

Hydroponics is a constructive technology for the places which lack sterile and cultivable land for the cultivation of crops. Every system has its own flaws, but if supplementary measures are taken then this system is able to achieve two times improvement in growth as well as in yield when compared to crops grown in soil.

REFERENCES

[1] Gericke, William F. (1937). "Hydroponics - crop production in liquid culture media". doi:10.1126/science.85.2198.177.

[2] Texier, W.: Hydroponics for Everybody - All about Home Horticulture. Mama Publishing, English Edition, Paris (2015), pp. 235.

[3] Zhang, He; Asutosh, Ashish; Hu, Wei (2018-11-27). "Implementing Vertical Farming at University Scale to Promote Sustainable Communities: A Feasibility Analysis".

[4] Kumar, Ramasamy Rajesh; Cho, Jae Young (2014). "Reuse of hydroponic waste solution". Environmental Science and Pollution Research. doi:10.1007/s11356-014-3024-3.

[5] Heiney, A. (Aug 27, 2004). "Farming for the Future". www.nasa.gov. Retrieved Nov 21, 2018.

[6] Jones, Jr., J. B. (2004). Hydroponics: A Practical Guide for the Soilless Grower (2nd ed.). Boca Raton, London, New York, Washington, D. C.: CRC Press. pp. 153–166.

[7] Stoner, R. J. (1983). "Rooting in Air". Greenhouse Grower. 1 (11).