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Hydroponics Technique in Horticultural Crops

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Abstract

Hi-tech production techniques are required in order to improve India's agricultural growth potential. One of the most popular systems or technologies that is being highlighted right now to overcome limits like as water availability, small land holdings, disease and insect incidence, difficult soils, and so on is "Hydroponics." Hydroponic agricultural production has expanded dramatically in recent years across the world because it provides for more effective use of water and nutrients, as well as better climate and pest management. Soilless culture is always hydroponics, but not all soilless culture is hydroponics. Growing media, nutrient solution, temperature, air, supporting materials, water, mineral nutrition, and light are the basic requirements of hydroponics. Hydroponic plants receive all of their vital nutrients in the form of nutrient solution, which is made up of fertiliser salts dissolved in water. This method of food production is more environmentally friendly than current methods. Consumer concerns about health, the environment, and even the cost and availability of water are driving the development of hydroponic growing systems. Soilless culture not only helps to increase the quality and quantity of agricultural output, but it also helps to solve soil problems.

Keywords: Hydroponics, Nutrient Solution, Growing media

Introduction

Hydroponics is a method of growing plants in nutrient solutions (water with fertiliser) with or without a mechanical support medium (sand, gravel, vermiculite, rock wool, perlite, peat moss, coir, or sawdust) (Sharma et al., 2018). The phrase 'hydroponics' is derived from two Greek words, "Hydro" and "Pons," which respectively represent water and labour. During the 1930s, W.F. Gericke of the University of California used hydroponics for the first time. W.J. Shalto Duglas, an English scientist, brought hydroponics to India in 1946. He created a laboratory in the Kalimpong district of West Bengal and authored the book 'Hydroponics-The Bengal System' (Pant *et al.,* 2018). 'Aqua (water) culture,' 'hydroculture,' 'nutriculture, "soilless culture, "soilless agriculture,' 'tank farming,' or 'chemical culture' are other synonyms for hydroponics. A 'hydroponicist' is someone who performs hydroponics, and a 'hydroponicum' is a structure or garden where hydroponics is used (Jones, 2014).

Importance of Hydroponics

- Crops can be produced in areas where there is no suitable soil for agricultural production or if the soil is infected with diseases.
- Labour is significantly removed for several intercultural activities including as tilling, growing, fumigating, watering, and other techniques.
- The system can achieve maximum production, making it economically viable in high-density, costly land locations.

- This technology can effectively employ water and nutrients. As a result, there is a lower risk of important chemicals being lost, resulting in less contamination of land and waterways.
- Using this technique, soil-borne plant diseases may be effectively removed.

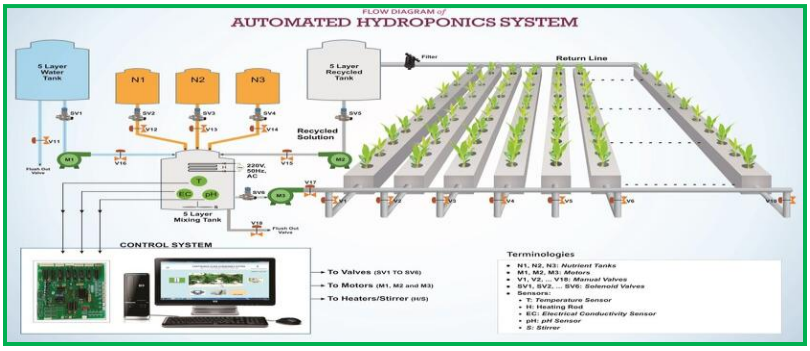

Figure: Flow Diagram of Automated Hydroponic System

- If utilised with extreme caution, water with high soluble salts can be used.

Benefits of Hydroponics

The hydroponic technique has recently gained popularity since it is a clean and reasonably simple technology with no risk of soil-borne illness, bug or pest infection, decreasing or eliminating the need of pesticides and their toxicity. Furthermore, plants require less growing time than crops cultivated in the field, and plant development is faster since there are no mechanical barriers to the roots and all nutrients are easily available to plants. This approach is particularly beneficial in areas where environmental stress (cold, heat, desert, etc.) is a significant issue (Polycarpou *et al.*, 2005). Crops grown in a hydroponic system are not affected by climatic change, therefore they can be grown all year and termed off-season (Manzocco *et al.*, 2011). Furthermore, commercial hydroponic systems are automated and are projected to minimise labour costs by eliminating weeding, spraying, watering, and tilling, among other traditional agriculture activities (Jovicich *et al.*, 2003).

Limitations of Hydroponics

- The cost of constructing a hydroponics unit per unit area is really expensive.
- Proper instruction or know-how is required before beginning hydroponically cultivated vegetable crop growth. It is critical to understand how plants develop and the principles of feeding.
- There is a risk of imported soil borne illnesses and nematodes quickly spreading to all beds on the same nutrient tank in a closed system.
- The majority of existing plant types adapted to the regulated growth conditions require extensive research and development.
- The grower must monitor the plants on a daily basis since the plant's reaction to excellent or bad nutrition is lightning rapid.
- The farmers must understand how to manage the climate inside the building.

Basic Requirements of Hydroponics

Nutrient solution, temperature, air, supporting materials, water, mineral nutrient, light, and, most importantly, growing medium such as sawdust, bark, chips, straw, gravel, rockwool, perlite, sand, and vermiculite, among others.

Nutrient Solution for Hydroponics and its managements: Hydroponic plants receive all of their vital macro and micro nutrients in the form of nutrient solution, which is made up of fertiliser salts dissolved in water. The stringent nutrient management programme determines whether a hydroponic technology succeeds or fails. A good hydroponic system requires careful manipulation of the nutrient solution pH level, temperature, and electrical conductivity (EC), as well as replacement of the solution as necessary. The more a nutrition solution's pH deviates from the required range, the less likely it is to succeed. For hydroponics, the optimal EC range is 1.5 to 2.5 dS/m. Due to osmotic pressure, higher EC prevents nutrient absorption, whereas lower EC has a negative impact on plant health and productivity.

Preparation of Nutrient Solution: Though hydroponic gardeners may make their own fertiliser combinations to make nutrient solutions with entirely water-soluble nutritional salts, there are a variety of formulas to pick from on the market. Insoluble precipitates are formed when some fertiliser salts react with one another. In the tank, for example, ammonium sulphate and potassium chloride combine to generate less soluble potassium sulphate.

The following properties should be present in any growth media used in a hydroponics system.

a. It must serve as a nutrition supply for optimum plant development and growth.
b. It should be capable of holding a lot of water.
c. It must concurrently deliver water and gases to the plant.
d. It must give enough plant support.

Organic growing media:

- **Coco peat:** Coconut husk is a by-product. Coconut peat is used to grow a variety of soilless crops such as tomato, capsicum, and other vegetables with minimal environmental effect. The coco peat's excellent water retention capacity acts as a buffer in hot temperatures and high crop load need without impacting air supply.
- **Rice hull:** Rice hulls are a waste product from rice milling. Rice hulls, despite their low weight, are particularly excellent in improving drainage. In media altered with rice hulls, however, nitrogen depletion is not a severe issue. Fresh rice hulls should not be used as a hydroponic system's growth media since they are likely to include impurities such as rice, fungal spores, germs, decomposing bugs, and weed seeds.

Inorganic growing media:

- **Perlite:** It's a grey white silicate substance with a neutral pH that expands from four to twenty times its original volume when heated to around 1600-1700 of This expansion is caused by the presence of two to six percent mixed water in the crude perlite rock, which causes the perlite to pop like popcorn. Because perlite is sterile, it is free of diseases, seeds, and insects
- **Sand:** In hydroponics, sand is a frequent growth medium. Sand is similar to rock, however it is much smaller. There is little prospect of fast moisture drainage since the particle size is lower and finer than normal rock. Sand is frequently combined with other materials such as Vermiculite, perlite, or coco coir. It aids in the retention of moisture as well as the aeration of the root mix.
- **Vermiculite:** Hydrated magnesium aluminium silicate is the chemical formula. The enlarged, plate-like particles that are formed have a very high-water holding capacity and help with aeration and drainage. Vermiculite has strong exchange and buffering properties, as well as the potential to deliver potassium and magnesium in large quantities.
- **Oasis cubes:** Oasis cubes have a similar appearance and qualities to rock wool cubes. However, oasis cubes resemble the hard green or white floral foam that woods use to support stems in flower arrangements. Oasis cubes are made of an open cell substance that can absorb both water and air. Although oasis cubes are similar to rockwool

Figure: Different Types of Media

cubes, they do not become wet as readily.

Strengths

- Hydroponics allows you to grow vegetables on any land that has access to water.
- Smaller sites can produce large harvests.
- Produce can command premium rates due to its superior quality.
- Because fewer labourers are required, the enterprise is less expensive.
- Integrated pest and disease control is a highly successful method.

Weaknesses

- To date, there has been no affiliation or tie-up with any industry for the purpose of selling products or forming bodies among hydroponics farmers.
- Expensive initial investment and capital outlay (capex).
- It takes more dedication and effort than traditional farming.
- There are currently no specialised norms or legislation in India.

Opportunities

- Hydroponically produced product may be branded, packaged, and sold in a clean, healthy, and distinctive manner.
- More cash crops like ginger, saffron, turmeric, and other spices should be grown hydroponically.
- In India, these crops are gaining popularity.
- High-yielding hydroponically cultivated vegetables can be offered to niche/urban markets.

Threats

- There should be no price rivalry between traditionally and hydroponically grown items, just quality competition.
- Some individuals have the misconception that hydroponics is unnatural.
- Certain soil-grown fruit, such as the Calyx-On tomato, is being aggressively marketed and may pose a threat to hydroponic produce.
- An inconsistency in supply might potentially sabotage market intake:

Future scope of hydroponics in India

- India's megacities are running out of potable water. Agriculture is the largest user of this water. Water savings of more than 80% can be achieved by switching from traditional agriculture to water-efficient technology like hydroponics, which may then be utilised for drinking water.
- In India, the majority of the veggies we eat contain leftover chemicals, which are extremely detrimental to our health. In addition, unlike the industrialised world, India lacks well-established methods for tracking and monitoring pesticide residue in food. Crops produced

Figure: Hydroponic System

hydroponically may be a rich source of nutrients. Hydroponically grown crops can be a very potent source of chemical free food commodities.

Conclusions

This study of the nutrient dynamics of hydroponic crops was driven by a need to fill a vacuum in the prior literature, and it has opened up new and potential areas of research in the field. The research quantified nutrient fluxes in open hydroponic crops, which is the first complete attempt to close the nutritional balance in these systems and offer fresh insight on the subject. Because fertiliser use has become one of the most main environmental trials associated with greenhouses, optimising the use of fertilisers in hydroponic crops is critical. According to the study, 51 percent of nutrients are leached on average, which may be decreased or recirculated (closed hydroponic systems). The similar thing happened with water, which could be adjusted to reach 30% of drainage, increasing water efficiency. However, any further reduction in fertiliser and water delivery has its limits, and any overadjustment might result in agronomic issues and yield loss. Significant quantities of nutrients remain precipitated within the perlite (substrate) after cropping, constituting between 3 and 7% of the input nitrogen, phosphate, and calcium, according to this study. This conclusion is notable since it was not taken into account in earlier research, which only looked at nutrient delivery (nutrient solution), leachates, and plant absorption when measuring recovery. Although the results for nitrogen, magnesium, and sulphur retention demonstrated strong tendencies, more research is needed to confirm the observed patterns. Because no pattern of buildup was detected, the nitrogen content of perlite samples used as crop substrate should be examined using a more accurate measuring technique with a measurement threshold lower than 0.1 percent.

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