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SOIL LESS CULTIVATION OF VEGETABLES CROPS

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Abstract

Soilless cultivation methods, particularly hydroponics, aeroponics, and aquaponics, offer significant advantages in vegetable farming. Hydroponics involves growing vegetables without soil, using nutrient-rich water and inert mediums like coco peat or perlite. Aeroponics uses a mist of nutrient solution to nourish plants suspended in air, while aquaponics integrates fish farming with vegetable cultivation in a symbiotic environment. The study highlights the benefits of soilless cultivation, such as precise control over water, pH, and nutrient levels, allowing for year-round production in diverse locations. Future prospects for soilless techniques include their potential role in space agriculture and addressing food security challenges in urban areas.

INTRODUCTION

Soil-less culture mainly discusses to the techniques of Hydroponics, Aeroponics and Aquaponics. The term Hydroponics was derived from two Greek word's hydro means water and ponos means labour. Simply it is known as growing vegetables using mineral nutrient solutions, without soil in which their roots are in mineral nutrient solution only/in an inert medium, such as coco peat, perlite, gravel, mineral wool, etc. (Rakocy, 2012) This cultivation technique helps to face the challenges of adverse climatic condition and also helps in production system management for efficient use of natural resources and reduction of malnutrition. Aeroponics is additional technique, somehow similar to hydroponics with only difference that under aeroponics plants are grown with fine drops a mist of nutrient solution (Ellis *et al*. 1974). Aquaponics vegetable cultivation technique is the combination of recirculating aquaculture and hydroponics that is used for fish and vegetable production. It has been gaining attention as it serves as abio-integrated model for sustainable vegetable production (Goddek *et al*. 2015).

OBJECTIVE OF SOIL LESS CULTIVATION

- Soilless cultivation is intensively used in protected agriculture to improve control over the growing environment and to avoid uncertainties in the water and nutrient status of the soil.
- Recently the type of soilless culture transformed from open to close-loop system.
- This system is known for better result in water use efficiency, while maintaining the quality of the yield. This study aims to describe the specific purpose of soilless culture specifically in close-loop system and how substrate nutrition produces the better quality of the yields.

FUTURE SCOPE

Hydroponics is the rapidly following technique of agriculture specially for the production of vegetable crops in the upcoming future. Due to over population and modern civilization, arable land is decreasing day by day, to coop-up such a situation new technology like hydroponics and aeroponics are additional channels of vegetable cultivation. To get knowledge about these techniques we need to study on some of the early adopters of related matter which plays crucial role in future for the production of vegetable crops. Hydroponics also have been using successfully in Israel (arid dry climate). A company Organistic, growing vegetables and other crops successfully by using hydroponic technique in shipping containers having size of 12.19m. It gives better yield that is 1,000 times more than the equal area of land could produce. It has been done deal to use hydroponics in 3rd world countries where water supplies are limited for normal cultivation. Soilless cultivation has the ability to feed millions of people in areas where both crops and water are scarce like; Asia and Africa. Soilless farming especially hydroponic technique will be crucial in future related to the space program for the vegetable production. NASA has been made many hydroponics researches plans in place, this will benefit in current as well as future space exploration, which will also benefit in the Moon or long-term colonization of Mars. As we know that there is no soil to support cultivation in space, and it is too difficult to transport soil through the space shuttles. So, soilless could be main key to the future of space exploration for the any crop production. It offers the potential for a larger variety of crop which will provides a bio-regenerative life support system in space. In soilless farming, the vegetables are grown in nutrient solution which is essential for proper plant growth and development process, they will absorb carbon dioxide and provide renewed oxygen through the plant's natural photosynthesis process. Hence, in this way we can predict that there is possible for long-range habitation of both the space stations and other planets where can produce crop without soil.

ADVANTAGE OF SOIL LESS CULTIVATION

- Soilless culture methods offer unique benefits such as capabilities to control water availability, pH, and nutrient concentrations in the root zone.

- Vegetables can be grown in any place like; roof of the building, balcony, ocean, room of house, stores, etc where there is no appropriate land empty of pathogens and salinity is available.
- For the soilless vegetable production, all cultural practices of soil cultivation such as weed, control soil solarization and others can be excluded because there is no weeds, no insect pest incidence which directly save the labor input and the needed time of work.
- It helps to saves labor and time due to fewer works on cultivating, tilling, watering,
- and fumigating weeds and pests.
- The advantages of this system are absence of soil-borne pathogens safe alternative to soil disinfection nutrients and water are applied more evenly to the plants, therefore reducing wastage and providing a situation closer to the ideal growing conditions; soilless cultivation has the capacity for increased yield.
- There are fewer chemicals used due to no use soils and while the weeds, pests, and plant diseases are heavily reduced. This helps to grow cleaner and healthier vegetables.
- Improvement in crop production could be more than 10-fold possibility to cultivate greenhouse crops and achieve high yields and good quality, even in saline or sodic soils, or in non-arable soils with poor structure enhancement of early yield in crops planted during the cold season, because of higher temperatures in the root zone during the day respect for environmental policies
- In many countries, the application of closed hydroponic systems in greenhouses is compulsory by legislation, particularly in environmentally protected areas, or those with limited water resources

DISADVANTAGES OF SOIL LESS CULTIVATION

- In some cases such as high installation costs and technical skills requirements.
- The initial capital investment is high for the set-up of this system of vegetable cultivation.
- Electricity is required to manage the whole system, if there is power outage, the system will stop working immediately, and plants may dry out quickly and will die out. Hence, a backup power source and plan should always be planned, especially for great scale systems.
- Introduction of soilless systems involves an increase of inputs for the construction and maintenance, compared to the cultivation in soil.
- The nutrient solution is circulated continuously to all the plant and excess water is again back to the same tank so, if there is and disease in a single plant it may be transmit immediately to other plants too.
- Relatively low insoluble salts.
- Can become hydrophobic once completely dry.

- Being porous and well-drained means, it can't hold water for long and needs to be watered frequently.
- Nutrients are exhausted and the media needs to be replaced at short intervals.

TYPES OF SOILLESS CULTIVATION (Kazzaz and Kazzaz, 2017)

There are two types of soilless vegetable cultivation system (closed soilless vegetable cultivation and open soilless vegetable cultivation).

A) In open soilless vegetable cultivation:

In this dissolved nutrient solution are normally supplied to the plants through dripping framework. In this system of vegetable production frameworks, a sufficient keep run-off must be kept up with a specific end aim to keep supply adjust in the root zone of the plant which help easy to uptake sufficient nutrient required for plant growth. It just uses the substrates and dribble frameworks. Moreover, there is a drip system used as closed system in case of use reservoir recirculating nutrient solution that essential for crops. It is further divided into following types;

i) Root dipping technique:

In this technique, vegetables are cultivated in pots having small holes at the bottom and are filled with substrate medium/soilless medium like coco peat and are placed in a container having required nutrient solution (Hayden, 2004). The lower portion of the pots (minimum 1–3 cm) remain in close contact with the nutrient solution. Plant roots are partially deep in the nutrient media and some roots are just hanging in the air. This is a simple, easy and cost-effective system to cultivate small leafy vegetables like coriander, celery, etc (Rousos and Harrison, 1986).

ii) Hanging bag technique:

In this technique, long cylinder shaped polythene bags are used which are closed at the lower end and connected to PVC pipes at the upper portion. Above a nutrient supplement tank bags are hanged vertically. Planting materials such as seeds, seedlings, etc. sown in netted pots and are softly pressed into holes in order to generate compactness. A micro sprinkler is used to circulate the nutrient solution. At the bottom of the bag for collection of excess nutrient solution there is placed solution tank. By using this technique, vegetables like; lettuce, bread leaf mustard, coriander, celery, etc. are successfully growing in recent days.

iii) Trench technique:

In this technique, vegetables are grown on trenches constructed using concrete blocks above ground. To prevent the growth media from direct contact with the ground the inner linings of trenches are covered by thick polythene sheets. The size and shape of the trenches is constructed according to

cropping nature. All required nutrient with water are circulated through the dripping system with the help of water pump. Vegetables like; lettuce, coriander, spinach, etc are successfully growing in this system.

B) Closed soilless vegetable cultivation:

In closed soilless vegetable cultivation frameworks, the dissolved nutrient solution are recycled and are observed and balanced in like manner. The dissolved nutrient solution must be test/observed and dissected in any event once every week to keeping the supplement adjustment. If there is no proper supervision of nutrient supplement it may escape of the balance which can cause the death of the plant. Furthermore, it includes following types which are mention in following paragraph.

i) Hydroponics system:

In this system, vegetables are growing without soil. Simply, it is defined as growing of vegetables in water. Plants need vitamins and minerals that soil can provide for them with light, H_2O, Co_2 and O_2 for proper crop growth and development. Inert medium like rocks or coco coir fibre, peat moss, vermiculite, etc are used as a growing medium and they are feed a solution containing macro and micro-nutrients. Almost all vegetables can be grown successfully trough hydroponically. It is world widely used by farmers and growers because of various advantages like; their roots do not need to reach for nutrients and crops can grow closer together which means more production from small area (Jones *et al*. 1991). The nutrient solution also keeps the constant amount of nutrients available all the time which results in proper growth of crop. Due to these all things combination making hydroponics crops are more productive than soil growing crops. Hence, many farmers in various countries are beginning hydroponics vegetable production. One of the major reasons to use hydroponics is about concern water use only use 10% whereas soil-based cultivation used more than 80% so, becoming more popular day to day- it significantly conserves water (Ali, 2017).

Hydroponics System View

ii) Aeroponic systems:

This system is a type of closed soilless vegetable cultivation system. Simply, vegetables are grown in air and the roots of the crops are hanging in air. For nutrient solution reservoir, sealed root chambers are used which are covered with polystyrene or other material. Usually nutrient solution misting is done every few minutes around the root zone of the plant with the help of water pump. It needs a short cycle timer that runs the pump for a few second every couple of minutes so, at the side of tank a timer is fitted to controls the nutrient pump much like other types of hydroponic technique. If the misting cycles are interrupted, roots will dry out rapidly because the roots are hang out to the air. This system consist three types of frameworks, the first framework is high pressure which don't generally used a water pump. The second framework is low pressure framework known as soakaponics. The water and nutrient solution is simply stream out of the sprinkler i.e. mister heads (more water pressure) by using standard submersible water pumps. The third framework is ultrasonic foggers that make a fog. A little water bead measure while, they do make a fog/mist (Burrage, 2014). All most all vegetable crops can be grown easily in this system.

iii) Aquaponic system:

This system is the integration of recirculating aquaculture and hydroponics systems which is used for double harvest purpose that is fish and vegetable production in a symbiotic environment. Water pump is used to pumped water from the fish tank to the plants. It do not need to add external nutrient to the crop because fish excreta is sufficient for plant growth and development. Fish excreta is rich in ammonia so, bacteria convert ammonia and nitrite to nitrate. Excess water is returned to the fish tank. It serves as a bio-integrated model for sustainable fresh and healthy vegetable production due to this has been gaining more attention in present days. Increasing popularity of this technique is the interlinking of aqua cultural and hydroponic procedures. It can also ensure food security in urban area where normal vegetable cultivation cannot follow. Likewise, resource scarcities such as decreasing fertile land, soil degradation, lack of freshwater supplies for the crop, and soil nutrient depletion add an extra challenge for soil-based vegetable farming. For mitigation of such a challenges review studies shows that aquaponic systems can be good solutions (Singh and Singh, 2012). In recent days the leading countries in aquaponics are Israel, India, China and Africa.

CONCLUSION

Soilless cultivation methods offer significant advantages in vegetable production, enabling efficient use of resources and precise environmental control. Hydroponics and aeroponics are gaining popularity globally, especially in regions with limited arable land or water resources. These techniques

not only boost crop yields but also minimize environmental impacts by reducing chemical use and soil-borne diseases. However, challenges such as high setup costs and reliance on electricity highlight the need for continued technological innovation and investment. Aquaponics, in particular, presents a promising model for sustainable food production by combining aquaculture and hydroponics. As interest in soilless cultivation grows, further research and adoption of these techniques could revolutionize modern agriculture, ensuring food security and resource sustainability for future generations.

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