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Review Article

Possibility of Hydroponics Technique for Crops Cultivation

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Abstract: Hydroponics is a popular technique of growing crops in nutrient solution with using any soil based growing medium under precise climatic controlled condition. It has tremendous possibility for revolutionizing agriculture system not only in developed counties but in also in developing countries. Hydroponics system also exhibit better growth of plants as compared to crop cultivation done following the conventional system of cultivation. Moreover as the hydroponic system is done in controlled conditions, so it is possible to practice cultivation throughout the year irrespective of prevailing outdoor condition. In recent times, hydroponic vegetable production system is getting popularity in urban area where it has been adapted by many progressive growers. Still implementation of the hydroponic system by regular grower has some challenges as limited study has been done to evaluated quality of water on growth of plants in hydroponics. This study demonstrates possibility of the application of hydroponic system for farming. Hydroponics is futuristic system of agriculture as it makes it possible to cultivate crop on nutrient solution. It has tremendous possibility to be explored in areas where soil is severely affected and is not suitable for agriculture. It is also a boon for urban areas, where land availability for agriculture purpose is very limited. With proper understanding and standardization of hydroponic system it can be effectively used for sustainable agriculture.

Keywords: Hydroponics, Aeroponics, urban cultivation.

INTRODUCTION

Increase in population in urban area has giving rise to many challenges for sustainable agriculture all over the world as this has severely restricted the land availability for crop cultivation. Moreover economic prosperity in past decade has increased the demand for quality produce irrespective of its cost. World economy greatly depends on Agriculture as it the major contributor not only for food but also provide raw material for most of the industrial produce (Van der Ploeg, J. D. 2014). But tradition agriculture system is resource intensive utilizing most of the fertile land as well as more than 70 percent of the world's freshwater resources (FAO. 2004). This has posed a challenge to continue sustainable agriculture as fertile land availability is being reduced severely along with limited availability of quality water for cultivation. In the present scenario efficient utilization of natural resources using advance technique is the only solution to sustain.

In case of urban areas growing own food is new trend which has been promoted as a form of food sovereignty as well as hobby. People are preferring locally grown organic food presumed to be better for health benefits. Recent prosperity in urban areas of even in developing countries has given rise for demand for quality agriculture produce irrespective of its cost. Irrespective of huge demand it is not possible to grow much crop in cities as land availability is a constraint. Hydroponics technique based on use of nutrient solution for crop cultivation has been promoted to have a solution for urban cultivation (De Zeeuw, H., & Drechsel, P. 2015).

'Hydroponics' word has its origin from Greek language where 'hydro' refers to water and 'ponos' refers to labour (Beibel, J.P. 1960). It is a new system of agriculture based on use of nutrient solution for plant growth and development (Bridgewood, L. 2003; & Hochmuth, G. J., & Hochmuth, R. C. 2001a). In hydroponic system it is assumed that soil is not necessary for plant growth actually it acts as a source of essential macro and micronutrients that regulate the plant growth and development. Thus, if soil is replaced with a solution having appropriate combination of macro and micro nutrients it is possible to raise a crop to its full maturity. In fact in many developed countries hydroponics is commercially viable well established technology (Maharana, L., & Koul, D. N. 2011). Hydroponic system makes it possible to cultivate crop throughout the year. Hydroponics has been presented as a system for intensive crop cultivation promoting self dependency for food production as it allows the increased production on limited land with enhanced

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quality in terms of visual appeals and nutritive status (Wortman, S.E. 2015).

POSSIBILITIES OF HYDROPONIC TECHNIQUE

Water Conservation through Water Recycling and Reuse

Hydroponic system is associated with water conservation, recycling and remediation of water. It has been demonstrated to have advantages in terms of reduced water requirement resulting in the ease of managing external factors. It has been reported that in case of hydroponic cultivation the water and fertilizer used have been decreased by about 10 times and 40%, respectively as compared to conventional system of cultivation.

Increased Revenue Generation

There have been many reports where hydroponic system has been utilized commercially. In Thailand expensive vegetables have been grown using this system. As these crops fetch more money it is justified to invest on hydroponic system where establishment of the initial setup is high. This has given rise to possibility to raise crop locally without adversely effecting the environment and making efficient use of natural resources along with reducing malnutrition (Butler, J.D., & Oebker, N.F. 2006).

Solution for Region with Problematic Soil

Hydroponics gives hope to the region where there is issue with soil fertility due to extreme pH range or non desirable soil texture or structure. In these regions, crop production is a challenge in itself and if somehow it is made to cultivate, the production is very less as compared to handwork involved in the whole process in form of human labor and money. Hydroponic system of cultivation is new ray of hope of such region if we could manage other resources such as water and other technical requirement for the system to be implemented successfully.

Urban Cultivation

Land prices are usually very high in densely populated urban area so for these areas, hydroponic system could provide a possibility to grow food in indoor conditions also.

Quality Enhancement of Produce

Hydroponic production has been demonstrated to have enhanced quality which could command better price in a market for such produce, resulting in better net profitability for the grower. Crop production using hydroponic technique allows for a better control of pests and diseases resulting in increased yield and consistent production.

Reduced Chemical Application

Resh and Howard suggested that of hydroponic system need minimum use of pesticides along with increase in yield and water conservation. Plant grows faster and the yield is more than that planted on soil. Moreover, hydroponic methods could provide proportion and sufficient nutrient content to meet the plant needs (Resh, H. M., & Howard, M. 2012).

Year Round Production

As the hydroponic system of cultivation is based on precise control of agro climatic factors such as light, relative humidity, temperature etc., so crop cultivation through this system is possible throughout the year. It can be utilized for off season cultivation also. Usually short duration crops are preferred for hydroponic cultivation (Putra, P. A., & Yuliando, H. 2015).

CHALLENGES FOR POPULARIZING HYDROPONIC SYSTEM

Although hydroponic system has tremendous potential in urban areas but still this technique is not getting popularity due to certain limitations associated to it. Some drawbacks of this system are as follows:

High Installation Costs

Hydroponics system is basically meant for protected cultivation under green houses having precise control of various growth parameter such as light, temperature, humidity, gas composition etc. So the initial cost of establishing this whole setup require is very cost intensive. This is one of the biggest limitations of this technique as farmer in developing countries hesitate to take a risk for investing in such systems.

Required Advanced Expertise in Crop Management

In case of hydroponic system well trained human manpower is must to operate the system. Although with basic training and orientation any person can adopt this system (Lee, S., & Lee, J. 2015). Maintenance of system is based on handling of the whole setup of system, the person supervising the whole polyhouse.

Regular Monitoring

Success of hydroponic system depends on precise and frequent monitoring to ensure that the nutrient and pH levels are optimal. As per Maharana and Koul among the factors affecting hydroponic production systems, the temperature of the nutrient solution is considered to be one of the most significant determinants of crop yield and quality (Maharana, L., & Koul, D. N. 2011). The temperature of the nutrient solution differentially affects crop absorption of water and nutrients (Wheeler, R. 2010; & Resh, H.M. 2013). Leaf nutrient concentrations may be used to detect the mineral nutritional status of plants and thus can help to expose variations in nutrient availability in different growing systems, while fruit nutrient content indicates

the nutritional value for human consumption (Liebisch, F. et al 2009).

There has been experimental proof where it has been demonstrated that tomatoes in indoor systems with selective greenhouse varieties are better adapted to low light and high humidity conditions than the field cultivars (Diver, S. 2000). Most profitable varieties of crops such as cereals, green leafy vegetables, flowers and fodder which grow well in hydroponic systems (Hassall. 2001).

Increased Operational Cost of the System

The plant nutrients required for the system is exclusive and expensive increasing overall operational cost of the hydroponic system.

Rapid Proliferation of Pathogens

Hydroponic system is usually a closed system. So if any disease occurs in this controlled system then there is possibility of rapid spread of it in the entire polyhouse.

TYPES OF HYDROPONICS SYSTEMS

Nutrient Film Based Technique (NFT)

In this system plant roots are dipped in a channel where a thin film of nutrient solution is flowing. It is advised that roots of the plants should be kept moist but not water logged. In case of NFT solution of nutrients, it should be pre prepared and could be stored in a tank. This solution is directed to the culture channels with of help of electric pump. The plants are grown in these channels where nutrient solution is circulated inside it. It is recommended that the roots of the plants should be exposed but not water logged, while the top portion of the plant are kept open. NFT could be successfully utilized for short term crops such as lettuce, leafy crops and herbs. Crop produced through this system are free from unwanted dirt and hence require less cleaning before consumption.

Substrate Based System

In type of hydroponic system, soil substrate such as as perlite or rockwool are used to grow the crop in such a way that the plant roots are in growing mediums and the nutrient solution is provided through drip irrigation This system is suitable for crops having three to four month life cycle such as tomatoes, cucumbers and peppers grow.

Float System

Most of the float systems are long, rectangular reservoirs made of cement or wood and lined with a durable polyliner. Holes are cut into a foam board that floats on the water surface, and plants are set in the holes in the net pots. The roots of the plant dangle in a highly aerated solution of nutrients. The float system can be an economical means of hydroponic crop production in areas where raw materials are scarce and hydroponic systems are not available.

Flow System

The hydroponics system based on Flow (also known as flood and drain) literally floods a growing area for 5 or 10 minutes, and then drains away the nutrient solution. The nutrient solution is stored in a reservoir located beneath the growing table. Ebb and Flow are popular in hobby systems but are not always used in commercial manufacturing. The plant roots are generally in a medium of perlite, rockwool, or expanded clay pebbles.

Aquaponics System

Aquaponics is an innovative system where there is a combination of aquaculture (fish farming) with hydroponic production. It is also a very good example of water recycling and reuse where the waste water from the fish tank which is rich in nutrients is redirected to hydroponic system where this nutrient rich solution is used for crop cultivation pumped into plant beds. It is also a system of bioremediation of water as through aquaponic system the plants help purify the water by consuming the nitrate and other nutrients. To establish efficient aquaponics system, it is must to establish a healthy microbial population which could convert ammonia present in fish waste into nitrite and then nitrate, thus providing easily absorbable readily available nitrogen to the plant promoting the growth of crop. The commercial aquaponic production system is designed using float, NFT and ebb and flow methods.

Aeroponics

Aeroponics is the type of hydroponic system where the plant roots are continuously exposed to nutrient rich mist.

FUTURE OPPORTUNITIES OF HYDROPONICS

Sustainable food production without over exploitation of natural recourses is a challenge for agriculture system throughout the world. To produce healthy and nutritious food with limited use of pesticides is requirement for better life for every individual. Intensive plant production systems based on hydroponic technologies such as aquaculture and aquaponics needed to be further improved to make it more effective in terms of water, resources and labor. In recent year there have been rapid developments in hydroponic farming which will encourage consumers towards food grown through this system.

Hydroponic has been seen as technology of future as it is already been researched by space agencies such as NASA for its relevance in the future of the space program. NASA has comprehensive hydroponics research plans in place that will support current space exploration and possible long-term Mars or Moon colonization (Dreschel, T. et al 2018).

It is a resource intensive crop production system which is based on utilization of nutrient

solution for crop cultivation (Mamta, S. 2013). Hydroponics has immense potential of crop cultivation in urban area where land availability for cultivation is a big constraint (Savvas, D. 2002).

Hydroponic production systems also has a potential for the treatment and reuse of wastewater in intensive aquaculture systems (Prayong, K. 2013). It has been experimentally demonstrated that aquatic plants can effectively act as an agent for bioremediation of polluted water (Pilon, S. E. 2005; & Prasad, MNV. 2007). There is great potential for application of treated municipal wastewater for agricultural irrigation (Meda, A., & Cornel, P. 2010).The integration of hydroponic system with municipal wastewater treatment has been experimentally proved to be effective along with reducing maintenance costs required for conventional wastewater treatment thus could be futuristic approach for resource conservation and sustainability (Magwaza, S. T. et al 2020).

CONCLUSION

Hydroponic technique has tremendous possibility for future which could be an alternative for conventional farming. In recent years Hydroponics based farming has soon exponential growth resulting in one of the fasted growing segment of agricultural sector with a possibility to dominate future food production. Overall hydroponic system promoted effective nutrient utilization with higher density planting resulting in increased productivity along with improved product quality. It is also useful for those regions of the world that have a lack of arable or fertile agricultural land. Thus Hydroponics is a viable option for conventional farming particularly in urban areas as well as regions with problematic soil conditions.

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