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Hydroponics-Plant without Soil

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Abstract-

Currently hydroponic cultivation is gaining popularity all over the world because of efficient resources management and quality food production. Soil based agriculture is now facing various challenges such as urbanization, natural disaster, climate change, indiscriminate use of chemicals and pesticides which is depleting the land fertility. Several benefits of this technique are less growing time of crops than conventional growing; round the year production; minimal disease and pest incidence and weeding, spraying, watering etc can be eliminated. Commercially NFT technique has been used throughout the world for successful production of leafy as well as other vegetables with 70 to 90% savings of water. Leading countries in hydroponic technology are Netherland, Australia, France, England, Israel, Canada and USA. For successful implementation of commercial hydroponic technology, it is important to develop low cost techniques which are easy to operate and maintain; requires less labour and lower overall setup and operational cost.

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Introduction-

Hydroponics is a technique of growing plants in nutrient solutions with or without the use of an inert medium such as gravel, vermiculite, Rockwool, peat moss, saw dust, coir dust, coconut fibre, etc. to provide mechanical support.The Term Hydroponics was derived from the Greek words hydro' means water and ponos' means labour and literally means water work. The word hydroponics was coined by Professor William Gericke in the early 1930s; describe the growing of plants with their roots suspended in water containing mineral nutrients. Researchers at Purdue University developed the nutriculture system in 1940. During 1960s and 70s, commercial hydroponics farms were developed in Arizona, Abu Dhabi, Belgium, California, Denmark, German, Holland, Iran, Italy, Japan, Russian Federation and other countries.Most hydroponic systems operate automatically to control the amount of water, nutrients and photoperiod based on the requirements of different plants (Resh, 2013).Due to rapid urbanization and industrialization not only the cultivable land is decreasing but also conventional agricultural practices causing a wide range of negative impacts on the environment. To sustainably feed the world's growing population, methods for growing sufficient food have to evolve. Modification in growth medium is an alternative for sustainable production and to conserve fast depleting land and available water resources. In the present scenario, soil less cultivation might be commenced successfully and considered as alternative option for growing healthy food plants,crops or vegetables (Butler and Oebker, 2006).Agriculture without soil includes hydro agriculture(Hydroponics), aqua agriculture (Aquaponics) and aerobic agriculture (Aeroponics) as well as substrate culture.Among these hydroponics techniques is gaining popularity because of its efficient management of resources and food production.Various commercial and specialty crops can be grown using hydroponics including leafy vegetables, tomatoes, cucumbers, peppers,strawberries, and many more. This article covers different aspect of hydroponics, vegetables grown in hydroponics system and global hydroponic market

Benefits and Limitations of Hydroponics

Recently hydroponic technique is becoming popular because this is clean and relatively easy method and there is no chance of soil-borne disease, insect or pest infection to the crops thereby reducing or eliminating use of pesticides and their resulting toxicity. Besides, plants require less growing time as compared to crop grown in field and growth of plant is

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faster as there is no mechanical hindrance to the roots and the entire nutrient are readily available for plants. This technique is very useful for the area where environmental stress (cold, heat,dessert etc) is a major problem (Polycarpou et al.,2005). Crops in hydroponic system are not influenced by climate change therefore, can be cultivated year-round and considered as off season(Manzocco et al., 2011). Further, commercial hydroponic systems are automatically operated and expected to reduce labour and several traditional agricultural practices can be eliminated, such as weeding, spraying, watering and tilling (Jovicich et al., 2003). Hydroponics saves large amount of water as irrigation and other kind of sprays is not needed and water logging never occurs. The problem of pest and disease can be controlled easily while weed is practically non-existent. Higher yields can be obtained since the number of plants per unit is higher compared to conventional agriculture.Although soil-less cultivation is an advantageous technique but some limitations are significant. Technical knowledge and higher initial cost is fundamental requirement for commercial scale cultivation (Resh, 2013). Plant in a hydroponics system is sharing the exact same nutrient, and water borne diseases can easily spread from one plant to another (Ikeda et al., 2002). Hot weather and limited oxygenation may limit production and can result in loss of crops.Maintenance of pH, EC and proper concentration of the nutrient solution is of prime importance.Finally, light and energy supply is required to run the system under protected structure

pH and Electrical Conductivity(Ec) Management

Plant nutrients used in hydroponics are dissolved in water and are mostly in inorganic and ionic forms. All 17 elements essential for plant growth are supplied using different chemical combinations. Hoagland's solution is used as most common nutrient solutions for hydroponic systems Cooper's 1988 and Imai's 1987 nutrient solutions were also used for growing leafy vegetables, tomatoes and cucumber. Proper pH and EC of the nutrient solution is very essential and should be maintained properly for optimum plant performance. Ideal EC range for hydroponics for most of the crops is between 1.5 and 2.5dS m-1. Higher EC will prevent nutrient absorption due to osmotic pressure and lower level severely affect plant health and yield. So, appropriate management of EC in hydroponics technique can give effective tool for improving vegetable yield and quality (Gruda,2009). As an example, yield of tomato under hydroponic system increased as EC of nutrient solution increased from 0 to 3

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dSm-1 and decreased as the EC increased from 3 to 5 dS m-1 due to increase of water stress (Zhang et al., 2016). Level of EC @1.5, 2 and 3 dS m-1 at vegetative, middle vegetative and generative phase, respectively had increased crop height, fruit number and pepper fresh weight.In a nutrient solution, pH determines the availability of essential plant elements. Optimum pH range of nutrient solution for development of plants is 5.5 to 6.5 (Trejo-Tellez and Gomez, 2012) for most species but some can differ from this range. Once the plants grows, it will change the composition of nutrient solution by depleting specific nutrients more rapidly than others, removing water from the solution and altering the pH by excretion of either acidity or alkalinity. Wang et al. (2017) found that mixture of three (HNO3,H3PO4 and H2SO4) acids was much more effective than only single acid for maintaining an optimal solution pH of 5.5 to 6.5. Change in pH may cause nutrient imbalance and plant will show some deficiency or toxicity symptoms. Hence, care is required for maintaining optimum pH, EC and nutrient level in hydroponic solution. Crops such as vegetables, spices, flower and ornamentals, medicinal plants, fodders and up to some extent cereals can be raised through soil less hydroponic technique.

Water Conservation in Hydroponic

As water becomes scarce and important as a resource, the use of hydroponics and other water saving technologies for crop production is needed now and is poised to popularize in time. Hydroponics uses substantially less water as compared to the soil farming. In soil farming, most of the water that we supply to the plants gets leached deep into the soil and is unavailable to the plants roots, whereas in hydroponics, plant roots are either submerged in water or a film of nutrients mixed in water is constantly encompassing the root zone, keeping it hydrated and nourished. Water is not wasted in this process, as it gets recovered, filtered, replenished and recycled. Waste nutrient solution can be used as an alternate water resource for crop cultivation under hydroponic system (Choi et al., 2012). Savings in irrigation water, fertilizer and increase in vegetable and water productivity under hydroponic system as compared to conventional agriculture. NFT based hydroponics can reduce irrigation water usage by 70% to 90% by recycling the run-off water. It is possible to effectively grow high value, good-quality vegetables under controlled hydroponic conditions using 85 to 90% less water than traditional soil based production. Water sources from groundwater or dam/river water commonly contain factors that can influence plant

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yield and affect plant condition, including salinity, dissolved solids and pathogens. While some of these factors can be beneficial to crops, others need to be minimized

Global Hydroponic Market And Commercial Hydroponic Production

The Global Hydroponics Market has been estimated to cross USD 25.2 Billion in 2020. By crop type, global hydroponics market includes tomato, cucurbits, lettuce & leafy vegetables, peppers and other food crops. Tomato forms the largest market segment and it accounts for 30.4% share of the global market, during 2018.Hydroponics crop production is expected to be more in tomatoes, lettuce and other leafy vegetables. As the consumers are becoming increasingly aware of the superiority of quality greenhouse-grown vegetables, the demand for hydroponics culture is rising in Europe and Asia-Pacific. Europe is traditionally the largest market that is implementing advanced techniques in hydroponics. Asia-Pacific forms the second largest market for hydroponics, which is expected to grow at a steady pace. Leading countries in hydroponic technology are Netherland, Australia, France, England, Israel, Canada and USA. Dutch are the world leader in commercial hydroponic having total area of 13000 ha under tomato, capsicum, cucumber and cut flowers (Netherlands Department of Environment, Food and Rural Affairs, NDEFRA) and this account 50% of the value of all fruits and vegetables produced in the country. Australian hydroponic production of vegetables, herbs and cut flowers of system valued about 300-400 million dollar which is approximately 20% of the total values of vegetables and cut flower production in Australia reported by Rural Industries Research and Development Corporation (RIRDC). Australia is the largest hydroponic lettuce producers in the world, and having strawberry cultivation is larger than USA and cut flower production is almost equal to USA. Canada and Spain are also expanding the area under commercial hydroponic system. Japan has started rice production by hydroponics technique to feed the people (De Kreij et al., 1999). Israel grows large quantities of berries, citrus fruits and bananas in the dry and arid climate. Currently, demand of hydroponics cultivation has been increased in all the developing and developed countries (Trejo-Tellez and Gomez, 2012). In India, several tracts of wastelands having poor quality soil but plenty of water can be brought under hydroponics. Now a day's peoples in various big cities like Delhi, Chandigarh, Noida and Bangalore are growing some leafy greens and small herbs and spices on their roof tops and balconies for fresh consumption. The future for hydroponics appears more positive today than any time over the last 50 years. The

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startup costs to implement a hydroponic farm can vary widely but, they are usually higher than soil- based farming costs. Therefore, to foster the hydroponics industry's growth, it is important implement technologies that reduce dependence on human labour and lower overall startup costs

Conclusions

In recent years hydroponics is seen as a promising strategy for growing different crops. As it is possible to grow short duration crop like vegetables round the year in very limited spaces with low labour, so hydroponics can play a great contribution in areas with limitation of soil and water and for the poorer and landless people. In India, the hydroponic industry is expected to grow exponentially in near future. To encourage commercial hydroponic farm, it is important to develop low cost hydroponic technologies that reduce dependence on human labour and lower overall startup and operational costs.