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A Novel Study of Soilless Culture and Physiological Importance of Nutrient Uptake

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SUMMARY

Broad cultivation area of agriculture is facing several significant issues with the development of civilization, chief among them being the decline in the amount of land available per person. Per capita farmland was 0.5 ha when there were 3 billion people on the planet in 1960, but it is now just 0.25 ha with 6 billion people and will be 0.16 ha in 2050. A significant reduction in arable area under cultivation is anticipated as a result of growing urbanization, industrialization, and iceberg melting (a clear consequence of global warming). Once more, soil fertility has reached a saturation point, and more fertilizer application does not result in an improvement in productivity. The production of food using traditional soil-based agriculture is also threatened by factors such as low soil fertility in some cultivable areas, reduced chances of natural soil fertility build-up by microbes because of ongoing cultivation, frequent drought conditions, unpredictable climate and weather patterns, temperature increases, river environmental damage, poor water strategic planning and waste of enormous water resources, a downturn in ground water level, etc. Under these conditions, it will soon be difficult to feed the whole population only through open-field agricultural production. In order to meet these issues, soil-less culture is unavoidably becoming more significant in the current environment. Plants are grown in soilless culture without the use of soil. Improving soilless culture techniques for food production have produced some encouraging outcomes globally in terms of saving space and water.

INTRODUCTION

The most readily accessible soil type for plants is typically soil. For successful plant growth, it offers anchoring, fertilizers, air, water, etc. Yet, soils can occasionally impose significant restrictions on plant development. Some of these include the presence of nematodes and disease-causing organisms, inappropriate soil reactivity, undesirable reduced soil, poor drainage, degradation from erosion, etc. Also, typical crop growth in soil (Open Field Agriculture) is rather challenging because it requires a lot of land, laborious work, and water. However, in other areas, such as urban areas, there is no soil suitable for crop growth at all, or there are few excellent cultivable arable lands available due to unfavourable topographical or geographical characteristics. The inability to get labour for traditional open field agriculture has recently become a severe issue. In these conditions, soilless culture can be successfully introduced.

Generally speaking, "soilless cultivation" refers to methods derived by the Greek terms "hydro" (which means water) and "ponos" (which means labour). It is a technique for growing plants without soil by employing mineral nutrition solutions. With their roots just in the natural nutrient solution or in an inert media like gravel or mineral wool, terrestrial plants can be produced. The method of growing plants without soil while keeping their roots submerged in nutritional solution is known as hydroponics. This method assists in managing the production system to effectively use natural resources, combat malnutrition, and meet the problems posed by climate change.

Nutrient uptake by plants

Due to the system's limited ability to buffer nutrients and its flexibility to adapt quickly, hydroponics requires careful system monitoring. The nutrients that arrive from the nutritional delivery mechanism and the plant's reaction to nutrients are two components of nutrition that must be taken into account. Critical nutrient levels for the majority of crop plants have been established. Sources of the nutrients and their properties. The type of substrate being utilized (volume and physical-chemical properties), the crop (species and stage of growth), the length of the receptacle, the crop and irrigation systems being used, and the local climatic conditions all affect how frequently and how much nutrient solution is administered. Plants need to be fed every day. The ideal time to deliver the nutritional solution is between 6 and 8 in the morning, though the amount of water needed will change significantly throughout the day and from day to day. In order to avoid damaging the leaves and the development of illnesses, the solution should only be sprayed to the roots. Plants shouldn't be permitted to experience water stress in these conditions because it will reduce their yield. Generally speaking, it is advised that you water the plants only once a week in order to drain out any leftover excess salts. Use twice as much water as is typically used, but without fertiliser additions. To avoid the buildup of harmful ions and an excessive rise in electrical conductivity in the root area, between 20 and 50% of the solution should be drained off. During daily watering, extra nutrient solution is emptied from containers and can be re-used for the following watering. You can get rid of this liquid at the conclusion of the week.

Constraints in Hydroponics

In a soilless culture, maintaining a sterile underlying cause environment is crucial for healthy plant growth. It is crucial to reduce the number of phytopathogens in the root zone, despite how challenging this is to do. Wilt is a disease that frequently affects hydroponic systems and is brought on by the fungi Fusarium and Verticillum. Pythium and Phytophthora species obliterate all save the primary roots. There are no reliable fungicides that can be utilised in hydroponics. For the management of Pythium on vegetable crops, only Metalaxyl has been found to be extremely effective, however it is not approved for usage. It has also been discovered that heating fertiliser solutions effectively prevents infections from growing in the root zone. By heating liquid fertilizer at 20–22 °C, Pythium-caused root death in tomatoes was defeated.

Importance of Hydroponics

Growing plants without soil has a number of benefits over soil-based growth. These gardens dependably yield the finest crops with excellent yields; gardening is hygienic and incredibly simple, requiring very little work. Since nutrients are delivered directly to the roots in this situation, plants develop smaller roots more quickly, may be grown closer together, and require less room and water overall to grow under soil-less culture than in soil-based culture. There is no possibility of a disease assault, weed infestation, or soil-borne insect pest. Generally, soilless culture offers effective fertiliser control, higher planting densities, and enhanced yield per acre alongside better produce quality.

It works well in areas of the world where agriculturally productive or arable land is scarce.

Limitation of soil less culture

Although soilless culture offers numerous benefits, it also has certain drawbacks. Although there are huge rewards, commercial application demands technical expertise and a sizable upfront cost. The soil-less cultivation is only used for high-value crops due to the high expense. The control of plant health must be done with great care. Ultimately, the system need energy inputs to function.

Future Scope of Hydroponic technology

Agriculture's fastest-growing industry, hydroponics, may eventually control how food is produced. People will use cutting-edge technology like hydroponics & aeroponics to establish extra channels of agricultural production when population rises and arable land shrinks as a result of poor land management. We only need to look at a few of the early investors of this technique to get a hint of what hydroponics will look like in the future. Due to the rapidly growing population, land is particularly valuable in Tokyo. The nation has shifted to hydroponic rice cultivation to feed the populace while protecting vital land mass. Without using any soil, the grains is produced in underground vaults. Four harvest cycles rather than the usual one can be carried out annually since the environment is precisely controlled. Moreover, hydroponics will be vital to the success of

the space programme. NASA has ambitious goals for hydroponics research that will advance both the long-term settlement of Mars or the Moon and ongoing space exploration. Hydroponics may hold the key to unlocking the possibilities of space exploration as we haven't yet discovered dirt that can sustain life in space and the practicalities of carrying soil via the space shuttles appear prohibitive. Hydroponics in space offers two advantages: It offers a biological component known as a bio-regenerative system of support and the opportunity for a wider variety of food.

CONCLUSION

Future industry growth is anticipated to be exponential as soil conditions for growing become more challenging. Particularly in a nation like India, where urban artificial composite is expanding daily, adopting soil-less culture is the only way to increase the production and quality of the produce and ensure the nation's food security. Yet, the deployment of this technology may be accelerated by government action and research institute interest.

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