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Aeroponics: The Future of Crop Production

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SUMMARY

Aeroponics, Hydroponics and Aquaponics are three considerably modern and popular means of growing plants especially due to fewer requirements of space and arable land. Soil less cultivation is intensively used in protected agriculture in order to improve control over growing environment and to avoid uncertainties in water and nutrient status of soil. Aeroponics is a process of growing crops suspended in the air or in mist without using soil. This newer high technology farming has become able to lead more people to grow plants on their own even within a very smaller quantity of space. It differs from conventional hydroponics which uses water as growing medium and essential minerals to sustain plant growth and also from in-vitro growing or plant tissue culture. On the other hand, aeroponics is conducted without a growing medium but as water is used to transmit nutrients, it is very often considered as a type of hydroponics. Aeroponics, the most technical among six types of hydroponic systems, is a simple concept adopted by a lot of home growers because of its good outcomes.

INTRODUCTION

By the end of the year 2050, population of the world is expected to rise by 3 billion people and almost 109 hectares of additional farmland will be needed to feed these burgeoning population. Besides, approximately 80% of the total arable land on this planet is presently utilized for farming and more or less 15% of this land has been rendered unusable due to poor management and rapid climate change and many other factors. One of the most important and proposed solutions is an integration of currently available technologies in a controlled environment high rise farm (CEHRF) depending upon an aeroponic system which is chosen for its 90% reduction in water use, 60% reduction in nutrient use, stimulated crop growth and higher density capabilities as compared to traditional farming. The word 'aeroponic' is derived from two Greek words like 'aero' meaning air and 'ponos' mean labour. Thus, aeroponic literally means "growing in air" and the principles are based on the possibility of cultivating vegetables whose roots are not inserted in a substratum or soil, but in containers filled with flowing plant nutrition. The roots of the crops are sprayed with nutrients at regular intervals; roots can avail the best condition of oxygenation and moisture and the conditions may allow better nutrient assimilation in a more balanced way with better and quicker development of the plants. The aeroponic system is more user-friendly and harvesting of crops is quite simple. While comparing with hydroponics, it offers lower water and energy inputs per square meter of growing area.

What is Aeroponics?

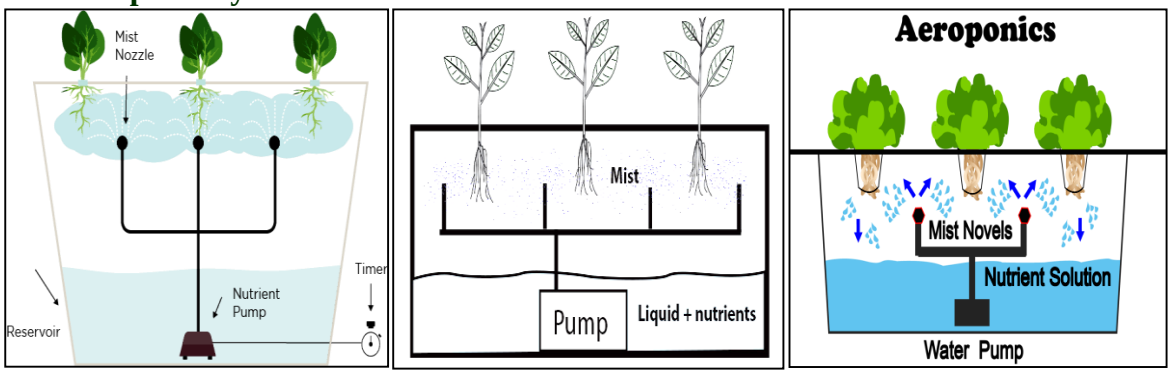
Aeroponics is fairly a new technology in the realm of gardening and farming which was invented in 1940s and has been a complete revolution for agriculture. Aeroponics is considered to be an improved process of growing plants in soil free environment or air or mist environment without an aggregate medium. The necessity of this method has been alarmingly increasing due to a clear cut demand for a more convenient way of cultivating plants. The roots are sprayed with nutrient rich water or fine, high pressure mist containing nutrient rich solutions at certain intervals which makes aeroponics a more advanced and innovative form than the hydroponic wicking systems, deep water culture, and other types resulting in faster growth, healthier plants, and higher yields using fewer resources. This technology can be effectively employed in growing nearly any type of plants and cultivars such as vegetables, nursery stock, houseplants and bedding. Besides, hundreds of plant species have been tested and grown successfully by commercial greenhouse owners, researchers and nursery operators through aeroponics. In practice, aeroponics systems are primarily used for the same applications as hydroponics systems, including leafy greens, culinary herbs, marijuana, strawberries, tomatoes, and cucumbers. One exception is root crops, which are impractical in a hydroponic system, but well suited to aeroponics, as the roots have plenty of room to grow and are easily accessible for harvesting. Fruiting shrubs and trees are impractical in aeroponics systems due to their size.

Fig.: Aeroponics

Tools Needed For Aeroponics

- A reservoir or container to hold the nutrient solution
- Nutrient pump
- Mist nozzles
- Tubing to distribute water from nutrient pump to the mister heads in growing chamber
- Baskets to suspend plants
- Enclosed growing chamber for root zone
- Watertight containers for growing chamber where the root systems will be
- Timer, preferable a cycle timer to turn on and off the pump

How Does the Aeroponic System Work?



- Plants are generally inserted into the platform top holes present on the top of a reservoir and placed within a sealed container.
- Due to absence of root zone medium for plants' anchorage, a rigid support collar should be prepared for holding stems and roots in place and plants upright but it must be flexible enough to allow space for roots to grow vigorously.
- The pump and sprinkler system creates vapour out of the nutrient-rich solution which is a hydro-atomized spray mixture of water, nutrients and growth hormones and sprays the mist in reservoir.
- This spray can provide the exact amount of moisture which may stimulate plant's growth and allow its development turgidly.
- The timer measures the spray intervals and duration for the plants.
- The secret of aeroponics lies in the quantity of oxygen exposed to the roots without a root zone media that can limit it; thereby, the plant roots will develop rapidly and grow in a moist air rich environment.

Types of Aeroponics

Low pressure aeroponics (LPA): It is most commonly used due to its easy set up, availability at any hydroponic shop, and low cost. In this system only a strong pump is required to move water onto the sprinkler heads to spray water around the rhizospheric region of the plants.

High pressure aeroponics (HPA): It is more advanced and quite costly to set up as it would require specialized equipment; therefore, often used in the commercial production rather than home growers. High pressure aeroponics runs at a very high pressure to atomize water into tiny water droplets of 50 microns or less which can create more oxygen for root zone than low pressure system, rendering it the most efficient system among all aeroponic types.

Ultrasonic fogger aeroponics/fogponics: It is another interesting type where growers usually use an ultrasonic fogger to atomize water into super small droplets of water seen only in the form of fog. Although roots absorb water of fine droplets, there is little moisture in fog and when it will be operated over long time, it may create salt that can clog the foggers.

Advantages of Aeroponics

- **Fast growth and higher yields:** Plants can grow quickly and are able to produce great harvests (almost 30% higher) due to the fact that they are suspended in midair and thus, their roots have constant access to oxygen. The plants are also much stronger and healthier due to oxygen richness. It is very much easy to replace old plants with the new ones. The mist used on the roots can also be sterilized to prevent plant diseases.
- **Easy maintenance:** It is easier to maintain as there is no requirement of weeding or pest control due to direct maintenance through provision of right amount of nutrients in mist solution. But the regular disinfecting and cleaning of the container used to contain roots and periodical cleaning of reservoir used to store the nutrient solution and irrigation channels of the system should be done in order to ensure that bacterial and fungal growth does not occur.
- **Fewer materials used:** Aeroponics requires lesser materials such as fertilizer, nutrients, and water as the plants can absorb nutrients and water more efficiently due to vigorous root systems.
- **Less space needed:** It requires less space than traditional methods. Some aeroponic systems allow stacking which greatly reduces the space requirement.
- **Great educational value:** Adults and kids can use this system to grow pet plants and learn a great deal about plants.
- **Farm almost anywhere:** Plants can be grown in a variety of places, indoors and out, due to the unique design and requirement of limited space, a clean water source, electrical outlet and sunlight or grow lights.
- **Grow sustainably and use up to 98% less water:** With closed loop technology, it can recycle water and nutrients; thereby using up to 98% less water than conventional farms, which is especially critical for drought stricken regions.
- **Control growing climate and ensure reliable results:** If plants are grown indoors or in a greenhouse, temperature, light, humidity and other variables can be controlled to consistently produce predictable yields, regardless of the weather.
- **Simplify the farming process:** It makes farming easier by automating feeding and watering cycles, eliminating weeding and digging, and minimizing pest risks.

Drawbacks of Aeroponics

- **Highly dependent on technology:** Aeroponics systems require a bit of finesse to operate effectively. It has an underlying disadvantage of being too much dependent on technology such as high-pressure pumps, sprinklers, and timers. If any component of the system failed or broke, it would be completely useless. If it breaks, nutrients can't be delivered to plants and they wilt and die. Besides, growers cannot even realize that the system is broken and they would not be able to save their plants. In this circumstance, they would lose all the plants in that container and this can be a hard blow to the harvest.
- **Research and understanding is needed:** It requires a certain technical understanding, knowledge and ability to set up and run the system and to create the perfect nutrient solution for plants because if the solution is unbalanced or has wrong nutrients, plants may die.
- **Costly:** It is highly expensive and not available to everyone. A basic setup would cost minimum hundreds of dollars.

- **Regular cleaning of the root chamber:** The root chamber must not be contaminated, otherwise, disease outbreaks may hamper the roots; therefore, the root chamber must be disinfected very often usually with Hydrogen peroxide. The growers need regular cleaning to keep them from becoming clogged by mineral deposits in the water.
- **Aeroponics requires constant attention to pH and nutrient density ratio** due to its sensitivity. Estimating the right ratio and applying this concept may be difficult for beginners and can only be performed by those who are more familiar with such systems. It also demands constant supervision.
- This system is highly susceptible to power outages and the growers will have to water plants manually if this happens. If the cultivator does not spray every few minutes or power goes out, dangling roots will quickly desiccate.
- The constant semi-moist environment of the root chamber inviting bacterial growth is one of the major drawbacks of all aeroponic systems.

CONCLUSION

As the supply of farmland and fresh water is rapidly growing scarce, human population is expected to suffer a lot. Considering this situation if we don't follow more efficient and sustainable farming methods, we'll likely face global food and water shortages by the end of 2055. Fortunately, there is a solution: vertical aeroponics — the soil free growing technology. Aeroponics is an increasingly popular way of growing plants within a limited space allowing quick growth of plants and bountiful yields. Once understood and properly set up, the running and maintenance of the system are very easy but to a beginner, it could be highly confusing and difficult. Nevertheless, with intensive research and proper planning, aeroponics is a great avenue for gardening.

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