

Aeroponics for propagation of horticultural plants: an approach for vertical farming

Abstract

Aeroponics is the technique of growing plant in soilless system in which roots hanging in the air acquire nutrition from spraying of nutrient mist. Although aeroponics was developed initially for the study of root system and related aspects by researchers, its paramount success in commercial crop production and large scale clonal propagation made soilless culture and vertical farming a sustainable concept for future. The technique is superior in terms of water use efficiency, less time and space requirement, seasonal independence, disease free plant propagation, large scale plant production etc. than the conventional methods of propagation. Thus it is widely being utilized in the field of horticulture as well as forestry also.

Keywords: aeroponics, horticulture, nutrient mist

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Introduction

Aeroponics is a farming technique involving plant cultivation in an enclosed chamber by aeration of roots through micro-spray of aqueous nutrient mist. The word aeroponic is derived from *aer* (air) and *ponos* (Labour) of the Greek.¹ Technique of aeroponics might be influenced by natural phenomenon of hanging roots of orchids in air and absorbing nutrients and moisture. Nevertheless the earlier report concerning the root development apple plant through spraying was published by Barker.² The absence of aggregates provided a fillip to the studies concerning roots of plants since it was easy to procure entire root structure without any mechanical damage as in case of soil and other aggregates. Later, some other researchers also developed the techniques of growing plants with their hanging roots absorbing water and nutrients from vapor/mist.³⁻⁵ The term 'aeroponics' was coined by F.W. Went in 1957 for the air-growing process while growing the coffee and tomato crops through the same technique.⁶ Though researchers have experimented with several crop plants grown in aeroponics system for various aspects of plant growth and development, the aeroponics apparatus for commercial use was first manufactured by R J Stoner's company GTi in 1983 and marketed as "Genesis rooting system".⁷ R J Stoner is considered as "father of american aeroponics technology". Now the technique has gained paramount success in horticultural as well as research arena.

Aeroponics is more advantageous than the conventional techniques of propagation i.e. lesser time and space requirement, year round crop production in controlled environment (irrespective of season), limited water consumption due to recycling process, completely organic farming as no need of fertilizers and pesticides, healthy (more nutrient availability) and disease free plants products, large scale clonal production for commercial and conservation purposes, easy access to root system reducing labor cost in case of root crops.⁸

Technical setup of aeroponics

A typical aeroponic unit consists of closed styrofoam chamber in which plant shoots are inoculated in holes made on styrofoam sheet and emerging roots remain dangled in the air. The chamber might be lined with black polysheet in order to assist in maintenance of optimum humidity and darkness in the chamber. Plants cuttings in aeroponics are misted through the nozzles which are evenly spaced and fixed into

PVC pipes for supply of nutrient solution. The pipeline is connected to the motor which pumps the nutrient solution at high pressure. To regulate the nutrient spraying for set time interval, a digital timer is connected to the pump. Space between nozzles and their pressure, spacing of styrofoam holes, pumping capacity of motor, duration of nutrient spraying and time gap between two subsequent sprays may vary according to the scale of aeroponics unit setup and cultivated plants. Nutrient solution dribbling from the suspended roots in the tank is pumped back to the water tank and recycled. In order to ensure the check of contaminating microbes affecting plant growth, nutrient solution is changed after certain time intervals depending upon the filling capacity of nutrient tank and growth of microbes. Infected plants are removed to check the spread of disease in other plants.

Horticultural aspect of aeroponics propagation

According to the International Society for Horticulture Science (ISHS) the horticultural crops include fruits, nuts and vegetable producing crops, medicinal and aromatic plants and plants of ornamental as well as landscape value. Aeroponics has been utilized for the production of various vegetable crops i.e. *Cucumis sativum*,⁹ *Lactuca sativa*,^{10,11} *Solanum lycopersicum*^{12,13} and leafy vegetables.^{14,15} Moreover, large scale production of potato seed tubers¹⁶⁻¹⁸ and yam (*Dioscorea* sp.) tuber production¹⁹ was also successfully achieved using this technique. Plants of ornamental value such as croton, geranium, philodendron, dracaena, carnation etc,²⁰ chrysanthemum²¹ and poinsettia²² have also been studied using this technique. Enhanced growth and root nodulation was observed in *Acacia mangium* (an important legume tree of timber and landscaping value) through aeroponic culture.²³ Aeroponics is also being utilized for the production of subtropical and temperate region crops in the tropical environment while manipulating their root zone temperature.²⁴

Application of aeroponics in medicinal plant cultivation has also been reported in recent years. Cultivation of medicinal rhizomes i.e. ginger (*Zingiber officinale*) and high valued root crops i.e. burdock (*Arctium lappa*), yerba mansa (*Anemopsis Californica*).²⁵ A new compound namely 2,3-Dihydrowithaferin A-3 β -O-sulfate (prodrug of withaferin A) was reported in *Withania somnifera* grown aeroponically.²⁶ Mehandru et al.²⁷ reported the clonal propagation

of three threatened medicinal asclepiads i.e. *Caralluma edulis*, *Leptadenia reticulata* and *Tylophora indica* using aeroponic culture. They observed the higher rooting percentage in stem cuttings grown aeroponically as compared to soil conditions. In a different study Salachas et al.²⁸ analyzed the effect of available root zone volume on yield as well as nutritional quality of cultivated holy basil (*Ocimum basilicum*) in an aeroponic system. Medicinal plants grown on aeroponic culture have also been evaluated for their antibacterial, antiparasitic as well as cytotoxic properties.²⁹

Conclusion and Future aspects

In conclusion, farming of horticultural crops as well as other aspects of plant propagation i.e. conservation threatened species and clonal propagation of trees could be successfully achieved through aeroponics in controlled environment. The technique could be a practical solution for commercial farming in the anthropocene where world is facing huge scarcity of fresh water and agricultural land to meet the food demand of 7.6 billion. Moreover, it could be the way forward for sustainable and productive farming technique in space.

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Conflicts of interest

Authors declare that they have no conflict of interest.

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