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"Hydroponics For Cultivation Of Medicinal Herbs- A Review"

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ABSTRACT- Due to rapid urbanization and industrialization, not only the cultivable land is decreasing but also the agricultural practices are causing wide range of negative impact on the environment. To overcome this, soilless cultivation is considered as an alternative method for the healthy growth of plants.information about different techniques of hydroponics was collected fron the internet source and also from published articles. The advantages and disadvantages of this techniques was analysed with respect to suitability for the cultivation of medicinal plants. Among this types the most commonly used technique was found to be nutrient film technique.

Keywords – Hydroponics , Nutrient Film Technique, Medicinal Plant Cultivation, alternative method.

BACKGROUND /NEED FOR THE STUDY -

Due to rapid urbanization and industrialization, not only the cultivable land is decreasing but also the agricultural practices are causing wide range of negative impact on the environment. To overcome this,soilless cultivation is considered as an alternative method for the healthy growth of plants. Among different soilless agricultural practices, hydroponics is gaining popularity all over the world as this technique requires less space and is done under controlled environmental conditions.

Hydroponics technology may be applied to produce high standard plant material throughout the year. Hydroponic cultures represent a technology for cultivating plants using solutions of water with nutrients without the need of soil. It facilitates plant cultivation under controlled growing conditions and by stimulation of secondary metabolism by using organic nutrients.

INTRODUCTION–

With increase in awareness regarding health, people are gradually turning towards natural or herbal medicines resulting in increased demand for medicinal plants. These plants are collected from the natural habitat and under minimal supervised environment. As a result, the density of medicinal plants in the natural habitat has started declining at a faster rate[1]1In addition to this, there is also possibility of batch to batch variation in phytoconstituents, resulting in varied results. So there is absolute need for cultivation of these medicinal plants in controlled and regulated manner without disturbing its phytochemicals. The over-exploitation of medicinal plant species has led to the cultivation of these under field conditions.

Hydroponics is the technique of growing plants in nutrient solution with or without use of an inert medium such as gravel, vermiculture, rockwool, peat moss, saw dust, coir dust, coconut fibre etc., to provide mechanical support .

The term hydroponics is derived from two greek words “hydro” and “ponos” hydro means water and ponos means labour[2].

The word hydroponics was coined by prof. William Geriche in early 1930s, which describes the growing of the plants with their roots suspended in water containing mineral nutrients[2].Growing of plants without soil in the nutrient medium solution was called solution culture which now has become popular and standard method for hydroponics cultivation.

The nutrients used in hydroponic systems can be taken from many different sources, including fish excrement, duckmanure, chemical fertilizers or artificial nutrient solutions[3]

Plants commonly grown hydroponically, on inert media, include tomatoes, *peppers, cucumbers, strawberries, lettuces, marijuana, Centella asiatica*Linn, *chillies ,calendula , lavender , Piper Species , Spinach , Lettuce , Coriander, Caraway Seeds , Brahmi ,Bhrngraj , Ashwagandha,* and model plants like *Arabidopsis thaliana*[4]

Components Of A Hydroponic System

Growing media – growing media is the substitute for the soil**.** Hydroponic plants grow in inert media which helps to support plants weight and attaches its root structure, however it does not provide any independent nutrition to the plant , instead it retains moisture & nutrients from the nutrient solution and then it provides to the plant.[5]

Air Stones and Air Pumps

Plants that are submerged in water can quickly drown if the water is not sufficiently aerated. Airstones which are used in the hydroponic solution which disperse tiny bubbles of dissolved oxygen through out the solution. Airstonesdonot generate oxgen on their own, hence they need to be attached to some external air pump via opaque food grade plastic tubing. This will prevent growth of algae and fungi[5].

Net pots

Net pots are mesh planters that hold hydroponic plants. The latticed material allows roots to grow out of the sides and bottom of the pot, giving greater exposure to oxygen and nutrients. Net pots also provide superior drainage compared to traditional clay or plastic pots[5]

Techniques

There are two main variations for each medium: sub-irrigation and top irrigation.For all techniques, most hydroponic reservoirs are now built of plastic, but other materials have been used including concrete, glass, metal, vegetable solids, and wood. The containers should exclude light to prevent algae and fungal growth in the nutrient solution.

Types of hydroponic systems [6]

Nutrient Film Technique (NFT)

Simple Wick System

Water Culture

Ebb & Flow System

Drip System (Recovery & Non Recovery)

Wick System Of Hydroponic[7]

Wick system is the simplest hydroponic system out of six; it is a user-friendly system of hydroponic because of its passive nature. In wick system components are stationary. It doesn't have any moving parts, hence it doesn't require any pumps or electricity. However, some experienced growers still like using an optional air pump placed in the reservoir. Since wick system doesn't need electricity to work, it's also fairly useful in places where electricity is not needed.

Principle of wick system[7]

Wick system works as its name says in this system water is wick to the growing plants from the reservoir by the simple process of capillary action. The nutrient solution is drawn into the growing roots from the reservoir with a wick. In simple terms we can say, it sucks up water in which nutrient solution is dissolved to the plants through the wick. The container with the growing plant in it basically is placed right above the container used as a reservoir. That way the nutrient solution doesn't need to travel up very far to get to the growing media with plants.

Components Of Wick System - growing container , nutrient reserviour , growing media , wicks

Wicks-

The wick itself is the most important part of the wick system hydroponics as the name of the system is derived from this component only. The role of the wick is to provide nutrients to the plant, maintenance of constant moisture level in the growing media , and the amount of water required for evotranspiration loss. Without proper wick absorbent the plant doesnot get enough moisture and nutrients which is necessary for the growth of the plant [8]

Some commonly preferred materials of wick system are fibrous rope, propylene felt strips, rayon rope or mop head strands, braided polyurethane yarn, wool felt, wool rope or strips, cotton rope, a stripe of fabric from old clothing or blankets, etc.

The Reservoir

Depending on the type of plant used and also based on the water requirement the wick system reservoir may be small or big , one must ensure that the water level remains high enough so that the (nutrient solution) doesn't need to travel up very far to the growing media and plant's root zone. The reservoir should be clean and water should be changed completely once in a while too to prevent the growth of algae or any other bacterias / micro organisms which grows easily in the stagnant water , & also if the container is not light proof ..

Growing medium– helps in absorption &moisture holding , media for wick system is coco coir chip , perlite & vermiculite.

Limitations of the wick system [9]

The major shortcoming of the hydroponic wick system is that they donot suit or work for larger plants that need more water to grow[9]

Wick systems also have the disadvantage of being less efficient when delivering nutrients to growing plant[9]

The plants take the nutrients as per their need and leave the rest of the nutrients in the growing medium. This can eventually cause a toxic build-up of minerals in the growing media. So flushing the excess nutrients from the growing media with plain fresh water has to be done regularly, like once a week or so to avoid its ill effect and harm to the hindering plant's growth[9].

Most plants require a wet-dry cycle for the plants to grow, but wicking beds create an environment with constantly moist soil which is unsuitable for many plants[10].

Water retained in a wicking bed leads to a build up of fertiliser and the evaporation of water from the soil combined with the upward wicking carries the excess salts concertation to build up to the upper soil levels where shallow rooted seedlings are planted[10]

Another issue is that the lowest soil levels in wicking beds are always wet, while the upper levels can be fairly dry. As a consequence, the depth of the plant rootswhich dislike 'wet feet' (constantly waterlogged soil) will be disadvantage in a wicking bed, and will usually fail due to rotten root. In addition to, it becomes a soggy, anaerobic (without air/oxygen) sludge that may promote diseases to the root[11]

the problem of wicking system is , it is costly & is not suitable for small areas , The need of large property for wicking beds is expensive to build[11].

Advantages Of Wick System[12]

It is easy and cheaper method

It doesnot require electricity

It is very water efficient [13]

Maintains the constant substrate moisture level in the container[13].

Rateof water level is directly related to evotranspiration loss

Less water usage compared to different systems

It can save both time and cost

Disadvantages[14]

This system is more suited to grow smaller non-fruiting plants, like lettuce and herbs , not suitable for large scale plants production ,

Plants that need more water supply is not suitable (eg – tomato , cuccumber)

Slow growing plants are not suitable

Good wick is required for sufficient supply of nutrients / water

Nutrients may settle down if the water is not moving / circulated / still

Nutrient Film Technique[15]

It is a type of hydroponic method in whichashallow stream of water containing all the dissolved nutrients required for plant growth is recirculated passes the bare roots of plants in a watertight thick root mat, which is developed at the bottom of the channel , the nutrient solution constantly flows pass the roots.

NFT systems are best suitable for climbers and shooters such as Cucumbers, pippali, and Tomatoes, etc. They can be used for leafy vegetables such as Lettuce, Broccoli, Basil, Palak, and, Chillies, beans, tomatoes etc

Principles Of Nutrient Film Technique[16]

Nutrient film technique systems have a constant flow of nutrient solution so no timer required for the submersible pump. The nutrient solution is pumped into the growing tray generally a tube and flows over the roots of the plants, and then drains back into the reservoir.

There is generally no growing medium used other than air, which saves the expense of replacing the growing medium after every crop. Normally the plant is maintained in a small plastic basket with the roots swinging into the nutrient solution. Nutrient film technique systems are very susceptible to power outages and pump failures. The roots dry out quickly when the flow of nutrient solution is interrupted.

The recommended flow rate for a Nutrient film technique system is typically between 1/4 gallon to 1/2 gallon per minute (1 to 2 liter's) for each grows tube (channel/gully). Or between 15 to 30 gallons per hour (60 to 120 liter's). flow rate beyond this leads to deficient of nutrition to the plants , the flow rate of the nutrients can be increased according to the growth of the plant[16].

Nutrient Film TechniqueReservoirs[17]

In nutrient film technique hydroponic , reservoir should be well aerated and temperature should be maintained properly , to manage the temperature fluctuations water chillers and submersible titanium heaters are used

Air pumps and air stones are used in order to ensure that plants are receiving correct aeration or not .

Advantages of Nutrient film technique:[18]

Very easy to inspect roots for a sign of disease, feed adequacy, etc. due to the absence of a medium.

Low water and nutrient consumption.

Environmentally friendly and minimize the risk of contaminating localized groundwater.

Unlike media based systems, avoid problems related to matters such as supply, disposal, and cost.

Comparatively easy to disinfect roots and hardware in comparison with other system types.

Plant roots can keep a uniform pH and conductivity thanks to regular feeding (and associated flushing) that prevents localized salt build-up.

Easy to build and maintain.

Very easily adaptable to different spaces and plant requirements.

Can be built relatively inexpensively.

No need for growing medium.

Reduced need for aeration of nutrient solution in the reservoir, due to the constant circulation

No fussing with timers or watering cycles.

Disadvantages of Nutrient film technique[19]

If the flow of nutrient solution stops, the roots will dry out and become stressed quickly.

The roots in the channels can be blocked by roots of vigorous-growing plants.

Usually in the hot weather , Pump failure can cause the death of crops in a few hours.

Not suitable for large tap-root systems like carrots.

Compared to run-to-waste systems, saline water is not suitable for the NFT, because the salinity of the recirculating water will gradually decrease.

Deep Water Culture Hydroponics / Deep Flow Technique / Floating Raft Technique [20]

Deep water culture (DWC) is a type of hydroponics method in which the plants roots are suspended in the nutrient rich solution and oxygenated water[20]i DWC is used to grow short-term, non-fruiting crops such as leafy greens and herbs, The large volume of water helps mitigate rapid changes in temperature, pH, electrical conductivity (EC), and nutrient solution composition[20].

This method is called Deep Water Culture for two reasons. typically grow with a reservoir that can hold a decent amount of water. More water meansmore stability in your nutrient solution, which means less monitoring and maintenance for you!

The second reason is because of how much of the root mass you submerge in the water. Plants grown in this system are **Cannabis, Tomato, Strawberry, and Pepper**

Advantages Of Deep Water Culture Hydroponics [21]

It accelerates the growth resulting from superior uptake of nutrients and oxygen. Aerating the roots improves water absorption as well resulting in improved cell growth within the plants. Also, there is no need for much fertilizer because the plants are suspended in the deep water culture nutrients.

It requires Very low maintenance once you set it up

Very little moving parts and assembly

Extremely fast growing time compared to soil

Disadvantages Of The DWC System[22]

If the air pump gets broken

In a non-recirculating deep water culture system, it is difficult to maintain the temperature .

The nutrient concentration, water level, and PH may fluctuate wildly; it needs to be checked constantly

In small systems, it is very easy to over or under calibrate

It can be difficult to maintain a consistent water temperature[23]ii

In small systems, calibration is very easy due to small scale[23]

If there is electricity outage or a pump failure, roots may be “drown” in low-oxygen nutrient solution[23]

Temperature–should be maintained mainly the air temperature at 75^{o} - 80^{o}F, and root zone at 60^{o} - 68^{o}F. Too warm temperatures will decrease the oxygen levels within the system

Managing pH Level - plant roots absorb nutrients at the pHof solution ranging between 5.5 to 7.0 for the majority of plants, depending upon plant variety and species).

Topping up the nutrient solution - as plants will absorb nutrients from the solution, the level of various nutrients present in the solution will be declining down henceperiodically top-up of the nutrient solution is required.

Oxygenating of nutrient solution – for the good growth of the plants Periodic oxygenated nutrient solution is required.

Plants should be taken care of any pest or disease or any contamination.

Limitations:[24]

Dwc is suitable for herbs

It is not suitable for large plants and slow growing plants

It is not suitable for flowering plants DWC system, here the water is static and not recirculating, so it can be more difficult to regulate temperature.

Ebb and Flow/ Flood and Drain[25] –

The ebb and flow or flood drain hydroponics is the method in which the nutrient solution is flooded at the specific intervals , which then drains back the nutrient solutions into the reserviour containing a pump and a timer .

Basic Components

The basic components of the Ebb & Flow system are the plant tray, reservoir, and submersible pump with timer.

PLANT TRAY [26]

The flood tray is pumped with full of nutrient-dense water from the reservoir below, which flows up through the bottom of the pots to the roots of the plants. The water is then drained back, allowing the roots to become completely dry and oxygenated before flooding again

THE RESERVOIR[27]

The reserviour consists of drain tube & fill tube

The reservoir is placed directly below the flood tray's stand. The reserviour is connected to the tray via a fill tube and a drain tube.

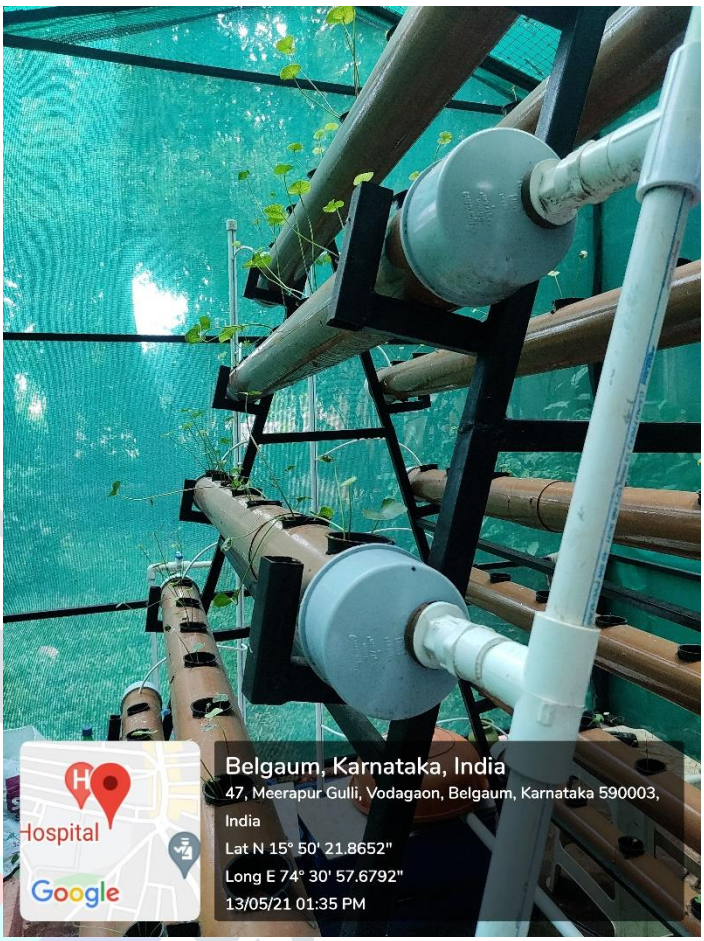
The fill tube attaches to a submersible pump with a timer, which controls the flow of water up into the flood tray.

The drain tube allows gravity to pull the water back into the reservoir after flooding so that the water can be reused.

The submersible pump with a timer allows for a lot of control in this type of system because you can customize the length and frequency of watering based on your gardens' needs.

DISCUSSION

In today's era due to scarcity of water and changing climatic conditions we are facing many difficulties in agricultural practice, it also provides high quality of biomass production , and provides healthy growth of plants with optimizes production of primary and secondary metabolities , use of chemical fertilizers and pesticides can be prevented and also seed borne diseases or pathogens can be prevented by using this technique . the most commonly suitable technique for growth of plants is nutrient film technique . Due to increase in population the land available for cultivation is declining.At the same time, the demand for medicinal plants is increasing day by day due to more number of people turning towards herbal based treatments for thier varied ailments. To overcome this problem hydroponics appears to be a better option as it requires less water and less area when compared to other soil farming methods . In hydroponics technique, theroots of theplants are submerged into the nutrient media or water ,where the roots are hydrated and well nourished . Among the six types of hydroponic system, NFT technique is the one which reduces irrigation water usage to 70 to 90 percent by recycling the run-off water. With this technique, we can grow high quality products, and also medicinal plants like lettuce(*lactuca sativa* L), *menthapiperata* L ,*Ocimumbasilicum* L , *salvia officinalisbidenstripartita* L , *leonarurusquinquelobatus* G [28], with potent phytoconstituents like total flavonoids content and tannins and secondary metabolities such as polysaccharides , extractive substances [29]. For the plants to grow hydroponically the Ph, temperature and also the TDS of the nutritions should be maintained.further scope of the study -for increasing the rare and endangered of the plants , many of the Himalayan species are in the range of extinction to review this we can use this technique , because of population exploitation and human habitation land is increasing , with the avalaible land . growing of medicinal plant in available land or lesser space and shortage of water has become a challenge nowadays hence to overcome this problems we can make use of this hydroponic technique of growing medicinal plants to fulfill the needs of pharmaceutical industries.



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CONFLICT OF INTEREST – None