ISSN No. 2583-3146

Soilless Culture – Is an Over View

Ratna Kumari N[1]*, Bindiya Y[2] and Srikanth D[3]

[1&2]Department of Horticulture, Agricultura College, Bapatla, ANGRAU

[3] Department of Vegetable Science, College of Horticulture,V.R. Gudem, Dr. YSRHU

Corresponding Author: ratnanavuluri@gmail.com

Introduction

Soil is usually the most available growing medium for plants. It provides anchorage, nutrients, air, water, etc., for successful plant growth. However, soils do pose serious limitations for plant growth too, at times. Presence of disease causing organisms and nematodes, unsuitable soil reaction, unfavorable soil compaction, poor drainage, degradation due to erosion etc., are some of them (Biebel, 1960). Besides, poor soil fertility in some of the cultivable areas, less chance of natural soil fertility build-up by microbes due to continuous cultivation, frequent drought conditions and unpredictability of climate and weather patterns, rise in temperature, river pollution, poor water management and wastage of huge amount of water, decline in ground water level, etc., are threatening food production under conventional soil-based agriculture. Under such circumstances, in near future it will become impossible to feed the entire population using open field system of agricultural production only. Naturally, soil-less culture is becoming more relevant in the present scenario, to cope-up with these challenges (Amrita Sengupta and Hirak Banerjee, 2012). Soilless culture can be defined as "any method of growing plants without the use of soil as a rooting medium, in which the inorganic nutrients absorbed by the roots are supplied via the irrigation water".

Media used in Soil less culture

a. **Coco Coir :**It is a by-product of coconut husk. Now a days it is commercially used in the pot cultivation of vegetables in the poly houses. Has an excellent air to water ratio with great water retention. Cocopeat is considered best in providing aeration, drainage and life to media.

b. **Rockwool :** It is produced by burning a mixture of coke, basalt, limestone and possibly from iron production. It is formulated to prescribe higher density to provide the air and water holding requirements of plants. It has advantages like Excellent water retention, pH balanced, it has negligible CEC, not buffered and not biodegradable.

c. **Peat :** Partially decomposed material mined from the swamps, hold moisture. It does not decompose quickly and it has a very stable source of Organic material.

d. **Perlite :** Natural volcanic material that helps aeration and water-holding capacity. It is neutral in pH and has negligible CEC. Although costs are moderate but perlite is an effective amendment for growing media.

e. **Vermiculite :** Mica mineral matter used to start seeds and cuttings, vermiculite is very desirable component of soil less media because of its high nutrient and water retention, good aeration, has neutral pH and low bulk density.

f. **Spagnum Mass :** Dehydrated remains of acid bog plants. It is relatively sterile and light in weight with high water holding capacity and as being able to absorb 10 to 20 times its weight of

water. It also contain small amount of minerals.

g. **Leaf Mold**: After the composting of leaves to 12 to 18 months leaf mold is ready for use. It may contain nematodes as well as weed seeds and noxious insects and diseases, so it should be sterile before use.

h. **Bark :** Is partially composted and screened material plant origin. When bark is removed from logs, varying quantities of cambium and young wood are included.

i. **Sand :** Fine sand (0.05mm to 0.25mm) does little to improve the physical properties of a growing media and may result in reduced drainage and aeration. Sand is a valuable amendment for both potting and propagation media.

j. **Rice Hulls:** These are by product of the rice milling industry. Rice hulls are extremely light in weight and very effective in improving drainage.

k. **Calcined Clays:** They have relatively high CEC as well as water holding capacity. It is very durable and useful amendment. This inorganic soil amendment is generally used to increase the number of large pores, improve aeration and drainage.

l. **Sawdust and Shavings:** These are by product of lumber mills. These materials decomposes faster rate than bark and because of its wider C : N ratio. It is close to neutral pH when thoroughly composted.

There are two classes of soilless culture:

(i) Hydroponics

(ii) Substrate culture: gravel culture, sand culture, bag culture, container culture, trough culture.

1. Hydrophonics

Hydroponics became popularaized in 1920's when Dr. William F. Gericke , University of California put laboratory experiments in plant nutrition on a commercial scale. He termed the these nutriculture systems Hydroponics.

The word was derived from the Greek words, Hydro (Water) and Ponos (labour) literally "Water Working"

It is a technique where the roots absorb balanced nutrients dissolve in water and many aggregates and media support plant growth.The basic requirement for successful hydroponic are

(i) Root aeration: root environment must be aerated to anaerobic respiration.

(ii) Root darkness: darkness around the roots to eliminate algae growth.

(iii) Physical support: for holding plants erect in water.

(iv) Nutrient supply

Advantages

- Automation is possible
- Plants are healthier and reach maturity faster.
- Weeds are eliminated.
- Soil-borne pests and diseases are eliminated.
- Indoor gardens grown using full-spectrum horticultural lighting.
- Grow, bloom and boost formulas used at the appropriate growth stage.
- Nutrients precisely controlled.
- Higher yields achieved in a smaller space.

Disadvantages

- Some water born diseases can spread rapidly in recirculation system.
- Specially formulated, soluble nutrients must always be used.
- Daily attention is necessary.

- A high level of expertise is required.
- Production is management, capital and labour intensive.
- Cost of initial investment.

Types of Hydroponic System

a. Wick system

b. Water culture

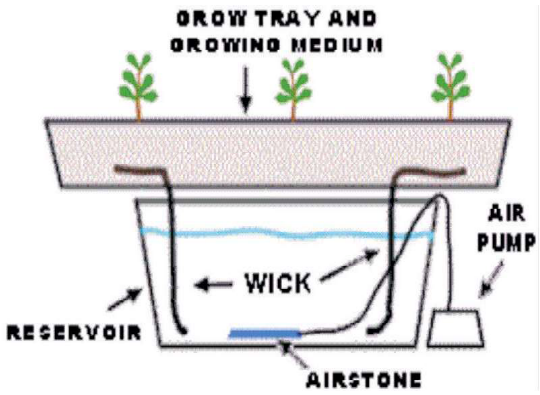
c. Ebb and flow

d. Drip system

e. NFT (Nutrient film technique)

f. Aeroponics

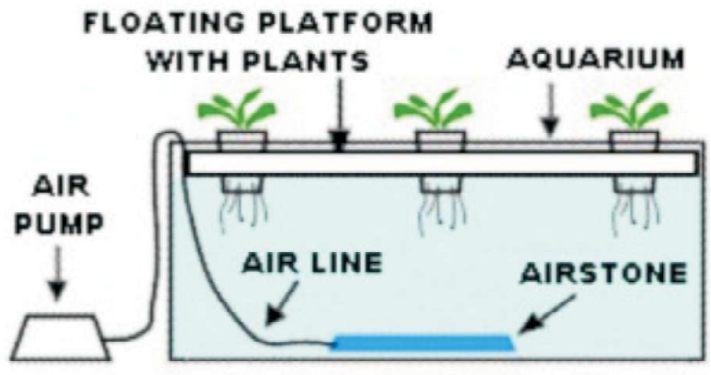
a. Wick System



- It is the most simple and basic form
- It is a passive system i.e., it contains no moving parts.
- Easier to establish and cheaper.
- Consists of grow tray, reservoir, wick and aeration system.
- Wicks are used to transport nutrition solution to the roots of plants in grow tray through capillary action.
- Aeration system is required to maintain level of oxygen in nutrition solution which is useful for the health of plants.

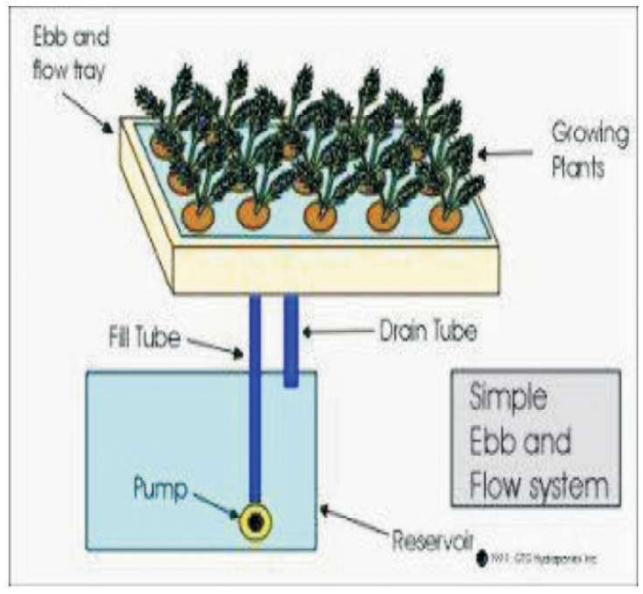
b. Water Culture System

- Simplest of all active hydroponic systems.
- Roots of plants are in direct contact with nutrient solution.



- Floating platform generally made up of Styrofoam and is used to hold plants.
- It consists of air pump, air line, air stone for supply of oxygen.
- Fast growing water loving plants like lettuce, herbs are ideal choice.

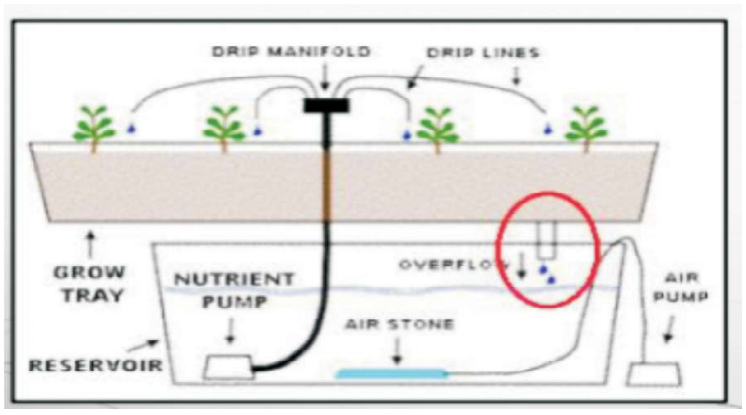
c. Ebb and flow system

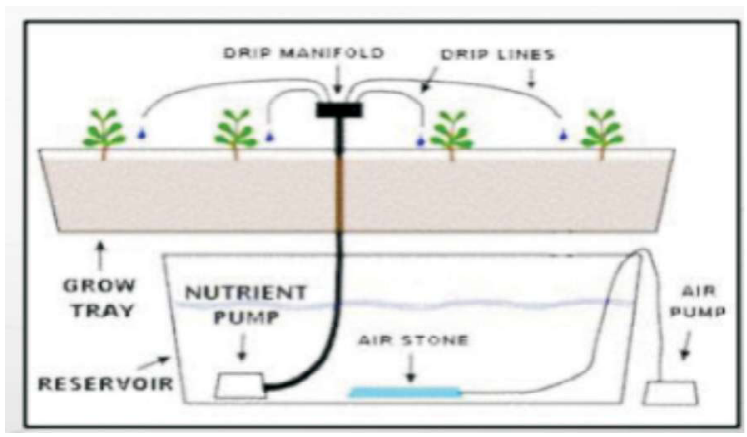


- As the name suggests, this system follow a continuous process of flowing nutrient solution to the roots and then falling back from the flood stage to the reservoir with certain period of time.
- The time period depend on type of plants, temperature and humidity and the type of growing medium used.
- Solution is flooded using water pump and drained out using drain tube.
- Main drawback is there is vulnerability to power outages and pump failures.

- The roots can dry out quickly when the watering cycles are interrupted.

d. Drip System





i) Recovery Drip System

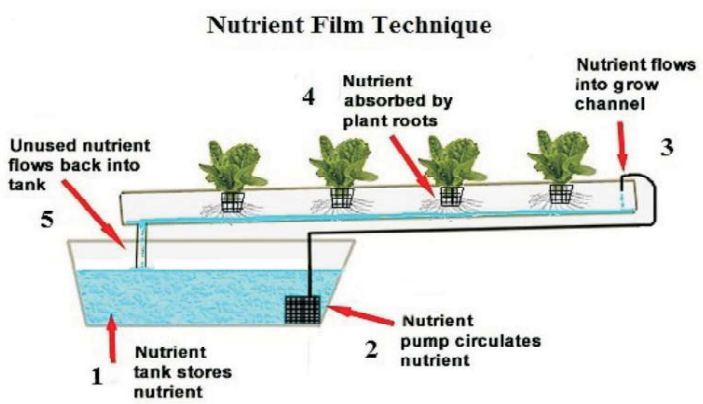
- This is the most commonly used type of drip growing system for home growers.
- This is because recirculating or recovery drip system collects back the nutrient solution that runs off into the water reservoir so that it may be used again.
- Thus, this type of drip system uses water more efficiently. Aside from that, this system works well even with an inexpensive timer since this doesn't require exact control of the watering cycles.
- However, same as the other hydroponic system that recirculates, a recovery drip system's nutrient solution may change both the pH and nutrient strength levels.
- This is because the plants use up the water's nutrients when it circulates repeatedly.
- Hence, there's a need to periodically check the system, adjust the pH when needed and change the nutrient solution regularly for the plants to have a balanced nutrient solution.

(ii) Non Recovery Drip System

- This is the kind of drip system that is used mostly by commercial growers.
- Though this does not reuse runoff water like the recovery system, non-circulating actually saves.
- This is because they require precise control of the watering cycles.
- With the use of the system's special cycle timers, they adjust the watering times to ensure that the plants get enough nutrient solution, as well as to avoid having much runoff.
- Unlike the recirculating system, non-recirculating doesn't require heavy maintenance. Since this doesn't collect back the runoffs, then the reservoir may be filled with balanced pH and nutrient solution. Thus, this doesn't require regular monitoring.
- However, there's still a need to keep the water circulating or moving in the reservoir for the heavy minerals not to settle at the bottom. This will keep a balanced pH adjusted nutrient solution.

e. Nutrient Film Technique (NFT)

- Plants roots are placed in a shallow stream of re-circulating water containing dissolved nutrients.
- Plants produce a thin root mat, part of which is located above the solution
- Because the roots are only partially submerged, plants are never in danger of the consequences of water logging.



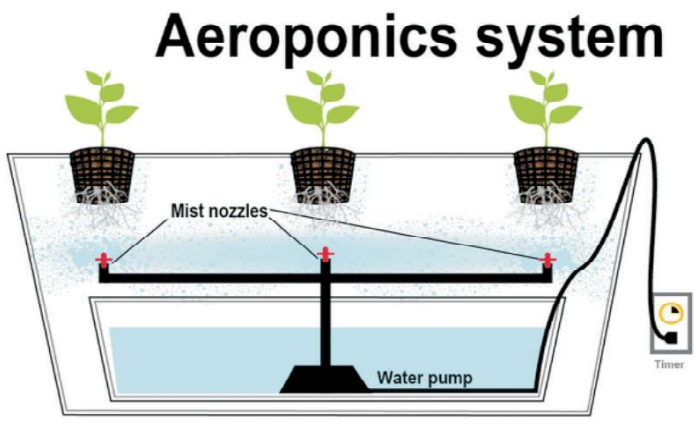
Advantage

- There is no need of pasteurization, the plastic film, used for lining is removed after each production cycle.
- No growing medium other than air
- Plant is supported in a small plastic basket with the roots dangling into the nutrient solution.
- The nutrient solution is pumped into the growing tray (usually a tube) and flows over the roots of the plants and then drains back into the reservoir.
- Constant flow of nutrition solution so no timer required for the submersible pump.

Disadvantage

- The high probability of pythium infestation.
- Very susceptible to power outages and pump failures.
- The roots dry out very rapidly when the flow of nutrient solution is interrupted.

f. Aeroponics



- Aeroponics is the process of growing plants in an air or mist environment without the use of soil or an aggregate medium.
- The word aeroponic is derived from Greek words 'Aero' means air and 'ponos' means labour.
- It is the most high-tech type of soilless culture.
- In aeroponic system the roots hang in the air and are misted with nutrient solution.
- The misting are usually done every few minutes, because if the roots are exposed to the air they will dry out rapidly if the misting cycles are interrupted.

Advantages

- The crops mature faster, which means there will be more harvests.
- Plants are not exposed to soil disease, so pesticide is needed.
- Crops are grown closure together, so more crops can be grown.

Disadvantages

- Maintenance of an aeroponics farm very expensive.
- Many consumers believe that aeroponically grown plants are not as nutritious as other grown plants.
- Costly to set up.

(ii) Substrate Culture

a. Container Culture

Different containers – PE, PVC or polystyrene buckets or pots (Plate 10) – are used. The volume of the containers varies from 12 to 18 litres and 1–2 plants per container are usually planted.

The container depth is important for adequate root development and plant growth

and the deeper the container the higher the ratio of air to water in the substrate. The container depth depends on crop, length of growing season and type of substrate. In general, a depth of > 20 cm is required.

A drip irrigation system is used to feed each plant individually and drainage is usually ensured by an overflow opening in the base of the container.

The growing media most commonly used in container culture are peat and coir (plain or mixed with perlite, pumice, lapilli or zeolite) and perlite. The same general operating procedures are used as with bag culture.

Advantages

- Low substrate volume.
- Containers are easily removed if there is any infection.
- Simplicity.

Disadvantages

- Needs labour to fill and Cost of container.

Future Scope of this Technology

Hydroponics is the fastest growing sector of agriculture and it could very well dominate food production in the future. As population increases and arable land declines due to poor land management, people will turn to new technologies like hydroponics and aeroponics to create additional channels of crop production. To get a glimpse of the future of hydroponics, we need only to examine some of the early adopters of this science. The hydroponics techniques produce a yield 1,000 times greater than the same sized area of land could produce annually. Best of all, the process is completely automated, controlled by robots using an assembly line-type system, such as those used in manufacturing plants. The shipping containers are then transported throughout the country (Butler and Oebker, 2006).

Hydroponics has the ability to feed millions in areas of Africa and Asia, where both water and crops are scarce. The benefits of hydroponics in space are two-fold: It offers the potential for a larger variety of food, and it provides a biological aspect, called a bio-regenerative life supportsystem. This simply means that as the plants grow, they will absorb carbon-di-oxide and stale air and provide renewed oxygen through the plant's natural growing process. This is important for long-range habitation of both the space stations and other planets.

Conclusion

The industry is expected to grow exponentially also in future, as conditions of soil growing is becoming difficult. Specially, in a country like India, where urban concrete conglomerate is growing each day , there is no option but adopting soil-less culture to help improve the yield and quality of the produce so that we can ensure food security of our country.

References

- Amrita Sengupta and Hirak Banerjee, 2012.Soil-less culture in modern agriculture.*World Journal of Science and Technology*. 2(7):103-108
- Balaraj Singh, 2005. Text book on Protected Cultivation of Vegetable Crops. ISBN – 10: 8127224731. Kalyani Publishers.
- Beibel, J.P. 1960. Hydroponics -The Science of Growing Crops Without Soil. *Florida Department of Agric*. Bull. p. 180.
- Butler, J.D. and Oebker, N.F. 2006. Hydroponics as a Hobby— Growing Plants Without Soil. Circular 844. Information Office, College of Agriculture, University of Illinois, Urbana, IL 61801.

❖❖