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Strawberry cultivation practices in soilless growing substrates: A review article

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Abstract
The strawberry cultivation practices have witnessed severe production losses caused by soil-borne diseases. Therefore, to avoid such type of diseases, a trend towards the use of soilless growing media in strawberry is increasing day by day throughout the world (Jansen, 1997) [6]. This system avoids sterilization of the soil, which has negative impact on the environment and human health. Further, this technique allows the growers to extend the cropping period and thereby increasing the fruit yield many fold with a minimum effort given in management practices (Jafarnia *et al*., 2010) [5]. The soilless growing substrates can broadly be classified into two categories *viz.* media other than soil (solid substrate) and water (hydroponics). Soilless cultivation is highly suitable for areas with contaminated or unfavorable soil condition for strawberry cultivation.

Keywords: Soilless growing, substrates, hydroponics

Introduction
Strawberry (*Fragaria* × *ananassa* Duch.) is one of the most important fruit crop belongs to family Rosaceae. It is a perennial herbaceous plant and bears soft attractive red coloured fruits with pleasant aroma. Earlier in Europe, strawberry cultivation was suffered from soil borne diseases, mainly *Phytophthora cactorum* and *Verticilium dahlia.* Methyl bromide was no longer allowed and other fumigants were expensive or not effective to manage this problem. Therefore, to counteract this problem, the first soilless substrate culture for strawberries started in Holland during the early 1980s. Each growing media has unique properties and exhibits direct and indirect effects on plant growth and productivity. Some technical and economic factors should be considered during choosing of soilless growing substrates. At the beginning, gravel or sand were the common growing substrates. Later, materials such as peat, cocopeat, perlite etc. have been popularized. Today, soilless cultivation is mainly confined in green house strawberry cultivation.

The physical, biological and chemical properties of soilless growing media are somewhat advantageous over soil (Wang *et al*., 2016) [12]. These kinds of media are more porous, lighter in weight, possess no or negligible amount of harmful chemical compounds, contain very less amount of phytopathogenic microorganism and easier to fertilize according to crop demand. It also has unique water holding and moisture retention capacity (Giménez *et al*., 2008) [4]. There are mainly two classification *viz.* Media other than soil (solid substrate) and water (hydroponics). Sometimes, solid growing media are also used in hydroponic culture to hold the plant in right position.

Soilless growing substrates helps in minimizes infestation of weeds, significant reduction in soil borne diseases, maximizes the fruit yield with highest quality, highly suitable for the regions having poor soil conditions, provides healthier environment for the development of roots and increases water use efficiency. Therefore, it has a very important role in strawberry cultivation.

Characteristics of Soilless Substrates
1. More porous and lighter in weight than soil
2. Possess no or negligible amount of harmful chemical compounds
3. Contain very less amount of phytopathogenic microorganism
4. Easily sterilized

5. Easier to fertilize according to crop demand
6. Unique water holding even at low tensions and moisture retention capacity
7. The solid growing media also releases mineral elements after decomposition

Types of Soilless Substrate Culture
Substrate culture is the cultivation of crops in a solid or liquid, inert or non-inert medium instead of soil. Substrate culture can be divided into solid substrate culture and water (hydroponics).

Suitable Soilless Solid Substrates for Strawberry Cultivation
Organic substrates: eg. Peat moss, Wood Residues (Sawdust, Barks), Rice hulls, Coconut peat, etc.

Inorganic substrates: eg. Perlite, Sand, Vermiculite, Calcined clays, Rockwool

Peat and peat like material
Sphagnum Moss
Sphagnum moss is a most desirable form of organic matter. It is widely available and inexpensive. It is used to improve the drainage and aeration in heavier soils. It has a capacity to absorb 10 to 20 times more water of its weight in water holding cells.

Hypnaceous moss
Hypnaceous moss decomposes more rapidly than some other peat types. Hence, it is suitable for media use.

Reed and Sedge
It is derived from the moderately decomposed remains of rushes, coarse grasses, sedges, reeds and similar plants. It is a Fine textured material, less acidic and contains relatively less fibrous particles.

Humus
Due to its rapid rate of decomposition and particle size, humus is considered to be undesirable for growing media use.

Residues derived from plant parts
Leaf mold: Leaf mold Improves aeration, drainage and water holding capacity of a potting mixture.

Saw dust
Excessive use of sawdust may restrict the growth of the plants due to presence of high amount of cellulose and lignin. Tree species having phytotoxic effects are not suitable for sawdust used in potting media.

Barks
These are primarily a bi-product of the pulp, paper and plywood industries. Suitable particle size can be obtained by hammer milling and screening.

Bagasse
It is a waste bi-product of the sugar industry. It facilitate the aeration and drainage of container media. It is available at low cost.

Rice Hulls
Rice hulls are very effective at improving drainage in potting media.

Coco Peat / Coco Coir / Coco Husk Fiber
It is made from coconut husk. It helps in developing strong root system and vigor. Its pH range is 5.7-6.8 and has an excellent drainage and aeration capacity. It has the ability to retain nutrients against leaching.

Sand
Sand is least expensive substrates and heaviest in weight.

Clay Particles
Perlite
It increases aeration and drainage. It has a tendency to float and moderate cost.

Vermiculite
It has a very high water holding capacity. It improves aeration and drainage. It Supplies little amount of K and Mg for the plant.

Other media
Rockwool
It produced as a loose flock, used as a growing medium in pots. It has a high moisture holding capacity. 95% of the volume of dry Rockwool slab is air space and only 5% is fiber.

Polystyrene Beads or Flakes
More commonly known by its trademarked name Styrofoam. It increases aeration and drainage, decreases bulk density and highly resistant to decomposition.

Performance of Strawberry in Soilless Growing Substrates
The media consisted of perlite + FYM (1:1) increased the plant height, number of flowers, leaf area, number of crowns, length of root, number of runners and yield in Chandler under protected condition reported by Thakur and Shylla (2018) [11]. Wang *et al.* (2016) [12] compared the most popularly used growing mediums against soil and reported that the strawberry (cv. Albion) grown in peat-rice hull mix media resulted the maximum dry weight of plant. The highest marketable yield of strawberry was reported in the plants cultivated in media containing 100% coconut coir. Jafarnia *et al.* (2010) [5] recorded that the number of fruits per plant, fruit dry weight, number of leaves and number of flowers per plant were the highest in 60% perlite + 40% peat moss, 100% perlite and 80% perlite + 20% peat moss in Frenso, Selva and Kordestan cultivars of strawberry, respectively. Caso *et al.* (2009) [2] found that growing media consisted of 100% rice husk significantly increased the length and weight of roots; fresh weight, length and diameter of fruits and yield of strawberry cv. Chandler. However, plants grown in 100% pumice exhibited the maximum fresh and dry weight and area of leaves. Growing media prepared with vermicompost + perlite + cocopeat in a ratio of 5:45:50 significantly improved the number of leaves, leaf area, length of petiole, number of runners per plant, number of crowns plant^{-1}and fruit yield in strawberry cv. Sweet Charlie reported by Ameri *et al.* (2012) [1].

Drawback of soilless cultivation
1. Very lighter substrate is unable to hold the plant in correct position.
2. Substrate having very high water holding capacity should be avoided. This may hinder the respiration of the roots.

3. The cost should be considered during selection of substrate.
4. Only few growing mediums are reused.

Strawberry cultivation in water (Hydroponics) culture
Water can also be use as a growing medium. Cultivation of strawberry in water called as a hydroponic culture.

Advantages of Hydroponics
1. One can grow plants anywhere.
2. It uses 20 times less water than soil based cultivation and 20 per cent less space for growing.
3. Requires less of water and pesticides.
4. Water and waste nutrients can be reused.
5. No intercultural operation like weeding, tilling, mulching, change of soil etc. are required.

Growing Techniques in Soilless Substrates
Strawberry plants in substrate culture are cultivated according to the growing media used, cost involved, skill and technical ability of the growers.
Vertical hydroponic pots system could accommodate maximum number of plants per unit area and resulted the highest yield of strawberry cv. Camino Real evaluated by Ramirez-Gomez *et al.* (2012) [9]. Murthy *et al.* (2016) [8] investigated the performance of strawberry cv. Festival in four different tire positions and noted that the earliest flowering, the maximum number of flower and fruits per plant, fruit weight, yield, fruit length, fruit diameter, marketable fruits, the maximum TSS and the minimum titratable acidity were in the fruit harvested from plants grown in top most tier.

Several techniques could be used
1. Poly bags: Simplest technique
2. Half-cut PVC-pipes: Pipes are filled with growing media and placed horizontally in tiers. The number of pipes placed horizontally may be varied according to availability of space.

Hydroponics
1. Circulating system (A reserviour is fitted to circulate the drained water)
2. Static system (The drained water is not reused)

Classification of hydroponic systems
Wick system
The wick system is the most simplistic type of hydroponic system requiring no electricity, pumps, or aerators. In most systems, plants are placed in an absorbent grow medium like coco coir, vermiculite or perlite, with a nylon "wick" running from the plant root into a reservoir of nutrient solution. The wick system brings the nutrient rich water from the reservoir to the plant.

Water culture
With water culture, roots of the plant are suspended in nutrient rich water and the air is provided directly to the roots.

Ebb & flow - (flood and drain)
Ebb and flow hydroponic systems (also called flood and drain), are popular with many home hydroponic gardeners because of its ease of use. In ebb and flow systems, the grow bed is flooded until it reaches a certain point. A drain allows the water to only get a few inches below the top of the growing medium, so it doesn't overflow.

Drip systems recovery / non-recovery
The drip hydroponic system is a widely used method among both backyard hydroponics and commercial growers as well. The nutrient solution runs through individual tubes to each plant, dripping over the roots and circulated back into the reservoir.

NFT (Nutrient Film Technique)
The method is a simple concept making it very suitable for backyard hydroponics and larger scales operations alike. In NFT hydroponic systems, plants are placed in channels or tubes with roots dangling in hydroponic solution. The system is slightly slanted so that the nutrient solution runs through the roots and down back into a reservoir.

Aeroponic
Plants are suspended in the air, often using foam inserts, with roots dangling in the tube or reservoir. The nutrient solution is then sprayed over the root system.

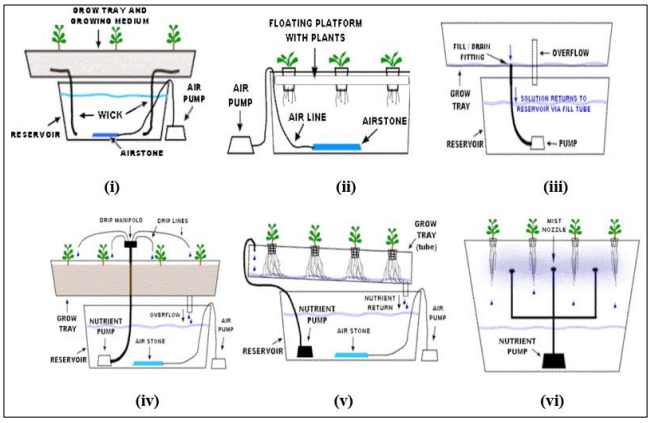

Fig 1: I. Wick System, II. Water Culture/True Hydroponic, III. EBB/Flow, IV. Drip System- Recovery Non-Recovery, V. Nutrient Film Technique, Aeroponics

Nutrient management in soilless growing substrates
Nutrients in strawberries, cultivated in growing media are supplied in the form of solution. Hence, the pH (5.5 to 6.5), salinity level (1.4 dS m^{-1}) and temperature (25 °C) of the solution should be strictly maintained (Economakois and Krulji, 2001) [3]. The frequency and amount of irrigation water varied according to growing media used.

Critical Growth Stages of Nutrient Application in Strawberries
1. Establishment and vegetative growth (2 times)
2. Anthesis and first wave fruit setting
3. Harvesting of first wave fruits
4. Anthesis and second wave fruit setting
5. Harvesting of second wave fruits
6. Like this way upto end of the fruiting season

Water management in soilless substrate
In alkaline environment, which increase availability of Mo and macronutrients and decrease availability of P, Fe, Cu and CO.
- High nutrient concentration > high conductivity reading > add fresh water

- Low nutrient concentration > low conductivity reading > add nutrients
- Overly alkaline solution > high pH reading > add carbon dioxide
- The frequency of irrigation depends upon the water holding capacity of the substrate
- The amount of irrigation water varied according to media volume

Disease and pest management

Strawberries in soilless substrate culture are sometimes encountered with crown rot and *verticillium* wilt and that could easily be managed by addition sterilized sand with nutrient solution at early stages of detection (Martínez *et al*., 2010) [7]. No severe pest attack was reported in soilless substrate culture of strawberry. However, use of yellow or blue sticky cards is found to be beneficial to manage the spider mite and thrips (Takeda, 1999) [10].

Disadvantages of Hydroponics

1. Requires higher initial capital investment
2. Require high degree of management skills
3. Limited only to high value crops
4. Energy inputs are necessary for commercialization
5. Sharing of nutrient solutions can spread disease and pest

Conclusion

Soilless cultivation is a profitable venture that enhanced the yield and quality of strawberry many fold and requires minimum efforts in management practices than soil grown strawberries. However, selection of growing media depends upon availability of materials and physical properties of the substrates. Use of mixed growing media along with either compost or vermicompost in optimum ratio could be suggested for strawberry cultivation instead of single growing media. Although, investigations on the use of mixed growing media are meager, that opens a new door of strawberry research and development.

Future prospects

Specially, in a country like India, where urban concrete conglomerate is growing each day, there is no option but adopting soilless culture to improve the yield and quality of the produce would be considered as prime importance. Only then, we can ensure our food security of the billions of population. Soilless substrate culture opens a “new door” to increase the production of better quality strawberry with negligible environmental impact. This technique proved to be an efficient system for cultivation of strawberries in adverse environmental ecosystems such as deserts and freeze mountainous regions. It has the capacity to feed millions in areas of under-developed or developing countries. At present, the demand of soilless cultivation of strawberries has been increased in exponential order. Therefore, the Government should ensure subsidies regarding this aspect.

References

1. Ameri A, Ali T, Mahmoud S, Gholam HD. Effect of substrate and cultivar on growth characteristic of strawberry in soilless culture system. African Journal of Biotechnology 2012;11(56):11960-11966.
2. Caso C, Chang M, Rodríguez-Delfín A. Effect of the growing media on the strawberry production in column system. Acta Horticulturae 2009;843:373-379.
3. Economakois CD, Krulji L. Effect of root-zone warming on strawberry plants grown with Nutrient Film Technique (NFT). Acta Horticulturae 2001;548:189-196.
4. Giménez G, Andriolo J, Godoi R. Closed soilless growing system for producing strawberry bare root transplants and runner tips. Pesquisa Agropecuária Brasileira 2008;43(12):1757-1761.
5. Jafarnia S, Sara K, Abdollah H, Ali T. Effect of substrate and variety on some important quality and quantity characteristics of strawberry production in vertical hydroponics system. Advances in Environmental Biology 2010;4(3):360-363.
6. Jansen WAGM. Growing media and plant densities for strawberry tray plants. Acta Horticulturae 1997;439:457-460.
7. Martínez F, Castillo S, Carmona E, Avilés M. Dissemination of phytophthora cactorum, cause of crown rot in strawberry, in open and closed soilless growing systems and the potential for control using slow sand filtration. Scientia Horticulturae 2010;125:756-760.
8. Murthy BNS, Karimi F, Laxman R, Sunoj VS. Response of strawberry cv. Festival grown under vertical soilless culture system. Indian Journal of Horticulture 2016;73(2):300-303.
9. Ramirez-Gomez H, Sandoval-Villa M, Carrillo-Salazar A. Comparison of hydroponic systems in the strawberry production. Acta Horticulturae 2012;947:165-172.
10. Takeda F. Out-of-season strawberry greenhouse production in soilless substrate. Advance in Strawberry Research 1999;18:1-15.
11. Thakur M, Shylla B. Influence of different growing media on plant growth and fruit yield of strawberry (*Fragaria* × *ananassa* Duch.) cv. Chandler grown under protected conditions. International Journal of Current Microbiology and Applied Sciences 2018;7(4):2724-2730.
12. Wang D, Gabriel MZ, Legard D, Sjulin T. Characteristics of growing media mixes and application for open-field production of strawberry (*Fragaria ananassa*). Scientia Horticulturae 2016;198:294-303.