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Effect of Growing Media on Growth, Yield and Quality of Strawberry (*Fragaria x ananassa*): A Review

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ABSTRACT: Strawberry is one of the most delicious, refreshing and visually appearing red fruit belonging to the family Rosaceae. It is a fruit with low calories and carbohydrates that is high in fibre, vitamin C and vitamin A. However, growth, yield and quality production of strawberry is declining due to growing urbanisation, industrialization etc. Growing media are composed of combinations of elements that offer water, air, nutrients, and structural support to plants. These media serve as a foundation for plants, and nutrients are supplied through the addition of fertilizers. The desirable traits of growing media for cultivation include greater porosity and lighter weight compared to soil, a distinctive capacity to retain water and nutrients under low tensions, and improved aeration for the root system. There are numerous ways to overcome the declining growth, yield and quality of strawberry but the best method is use of growing media. The present review focuses on the Effect of Growing Media on Growth, Yield and Quality of Strawberry (*Fragaria* × *ananassa*).

Keywords: Flavourful, urbanisation, fertilizers, strawberry, growing media.

INTRODUCTION

The strawberry (*Fragaria* × *ananassa* Duch.) is a prominent soft fruit that thrives in both humid and arid regions, with optimal day temperatures ranging from 22 to 25°C and night temperatures between 7 to 13°C, suitable for cultivation in lowlands and hills up to 3000 m. Belonging to the Rosaceae family, it is a diminutive, creeping, perennial, stoloniferous herb and is commercially propagated through runners (Islam *et al*., 2021). Commercially cultivated strawberry (*Fragaria*× *ananassa* Duch.) is a monoeciousoctaploid (2n=56) hybrid originating from two dioeciousoctaploid species, *Fragaria chiloensis* Duch. and *Fragaria virginiana* Duch. (Bowling 2000) with a basic chromosome number (x) of 7. Botanically, strawberries are aggregate fruits with seeds on the surface of a red fleshy receptacle (Darnell, 2003). They are a significant natural source of bioactive compounds containing 95% water and 5% dry matter (Ariza *et al*., 2016). These fruits are rich in vitamins and minerals, providing vitamin-C (94 mg/150 g), vitamin-A (45 IU/150 g), proteins (1.0 g/150 g), and essential fatty acids from the seed oil. Strawberries are also abundant in manganese, potassium, iodine, magnesium, copper, iron, and phosphorus. Additionally, strawberries contain non-nutrient elements like polyphenolic phytochemicals (Giampieri *et al*., 2012).

Strawberry may thrive in a variety of soil types, but the best are sandy to sandy loam. Strawberry requires a lot of organic matter to keep the soil moist, which helps it keep its physiochemical properties. For good growth, many forms of organic growing media are used in the majority of production systems in the commercial and ornamental sectors of horticulture. Soilless cultivation is gaining popularity as a viable alternative due to the contamination of agricultural land caused by excessive fertilizers and insecticides aimed at maximizing productivity per unit area. Soilless culture offers a yield advantage, outperforming conventional growing methods (Nafiye *et al*., 2015). Anticipated declines in arable land due to urbanization, industrialization, and iceberg melting further contribute to the attractiveness of soilless cultivation. This method minimizes weed infestation, reduces soil-borne diseases, and acts as a nutrient and water reservoir. Growing media have proven effective in boosting crop output in horticulture. Utilizing soil as a basic medium is common due to its accessibility and affordability. Growth media enable precise control over water distribution, nutrient levels, pH, and root zonal temperature. This not only enhances strawberry yield potential but also improves fruit quality. To supplement soil with necessary nutrients for seedlings, organic matter like vermicompost, vermiculite, perlite, and cocopeat is added (Wang *et al*., 2016). Perlite and vermiculite are widely used in horticulture, providing drainage, aeration, and water-holding capacity. They are accessible, non-toxic, safe, and reasonably priced, with a slightly neutral pH, making them valuable components. Industry experts and researchers anticipate market growth due to the advantages of soilless cultivation and the projected global population increase through 2050 (FAO, 2017b).

DIFFERENT MEDIA OR SUBSTRATES

Coco peat. Coco peat, a byproduct of the coconut industry, is a commonly utilized substrate for its affordability, aeration, drainage, and durability. It is available both in loose form and as compressed bricks, offering cost-effective transportation. Weighing around 4–5 kg, these bricks can expand to 4–5 times their volume when water is added after loosening. It is recommended to treat coco peat with steam or other disinfection methods before use.

Vermiculite. Vermiculite, an aluminum–iron–magnesium silicate, exhibits mica-like characteristics and expands into open-flake structures when subjected to high temperatures. Available in various grades and particle sizes, the choice of vermiculite depends on the size of nursery pots. Finer grades are suitable for small pots and nursery trays, while larger or coarser grades are preferable for large containers. Vermiculite, with its range of pore spaces, can retain a substantial amount of moisture upon wetting. It contains essential minerals, including calcium and magnesium, and maintains a nearly neutral pH. Highly valued in soilless root substrates, vermiculite offers excellent nutrient and water retention along with effective aeration, all within a low bulk density.

Perlite. Perlite, a crushed volcanic rock subjected to heat expansion, transforms into a lightweight, white material. Sterile and possessing a neutral pH, perlite enhances air space and water drainage in the nursery medium. Its durable nature prevents easy breakage, and it has the capacity to hold approximately 3–4 times its weight in water. Employing perlite helps maintain a lighter weight of the medium compared to soil.

Saw dust. It shares similarities with peat moss, and its quality is influenced by the type of trees involved. It could contain potentially harmful substances like resins, tannins, or turpentine. Being acidic, it needs the addition of limestone to neutralize its pH.

Bark. It is a residue from sawmills, employed in both pot cultures and greenhouses. Offering cost-effective aeration, it can be used alone in containers or blended with one-fourth part peat moss to enhance water-holding capacity. Generally, bark particles smaller than 3/8 inch (9.5 mm) are utilized as a growing medium. Unprocessed bark has minimal nutrients and a very low pH (3.5–6.5). To elevate the pH to at least 6, dolomite lime may be added to the bark medium.

Rock wool. Produced by burning a mixture of coke, basalt, limestone, and slag from iron production, it is finely ground into a powder or granular form. When incorporated into the growing media, this powdered substance offers effective aeration and water retention. With a slightly alkaline nature, it neither adds nor retains nutrients significantly, prompting its combination with other growing media like sphagnum peat moss.

Sphagnum Peat moss. It is alternatively known as peat moss or peat. Peat is a prevalent component in many soilless substrate media due to its affordability and widespread availability. It results from the partial decomposition of plant material in peat bogs with limited oxygen. All types of peat exhibit excellent water-holding capacity, a high Cation Exchange Capacity (CEC), low nutrient content, low pH (approximately 3 to 4.5), and necessitate the addition of limestone to regulate the pH.

Sand. Serving as a fundamental element of soil, sand features particle sizes ranging from 0.05 mm to 2.0 mm in diameter. It enhances aeration and drainage with minimal cost involved. Despite being susceptible to diseases and pests, sand, when sterilized, can function effectively as a medium for both potting and propagation.

Importance of growing media in strawberry. The strawberry, classified under the Rosaceae family and Fragaria genus, is rich in dietary fiber, carbohydrates, potassium, vitamins, and various nutrients. Growing media, comprised of mixtures offering water, air, nutrients, and plant support, play a crucial role in cultivating strawberries. These media support plants, while added fertilizers contribute necessary nutrients. The pore spaces in the media ensure adequate water and air supply. Soilless media, being lightweight, readily available, and suitable for containerization, offer advantages over mineral soils. Notable benefits of growing media include avoiding land rotation, reducing water and fertilizer usage, achieving higher yields, minimizing pesticide needs, and gaining better control over the crop (Azam *et al*., 2019).

Limitations of growing media in strawberry. Typically, the initial investments for adopting growing media in strawberry cultivation are greater than those for traditional soil-based methods. Strawberry growers venturing into this approach must acquire new knowledge about managing crops in growing media. This includes understanding optimal fertilizer schedules, as well as familiarizing themselves with new parameters such as EC and pH levels, and irrigation volumes. Ensuring the right water quality is crucial in this cultivation method, and there is also a risk of potential contamination in the growing media (Gruda, N.S., 2019).

Effect of growing media on yield and quality of strawberry. Growing media helps in increasing the growth and yield of various fruit crops in the horticulture sector. Thakur and Shylla (2018) executed an experiment to study the Influence of Different Growing Media on Plant Growth and Fruit Yield of Strawberry (*Fragaria* × *Ananassa* Duch.) cv. Chandler Grown under Protected Conditions. The design followed was Completely Randomized Block Design (CRBD) for statistical analysis of the results obtained. The experiment had six treatments [T1 – Perlite, T2 - Perlite + FYM (1:1), T3 – Cocopeat, T4 - Cocopeat + FYM (1:1), T5 - Perlite + Cocopeat + FYM (1:1:1) and T6 - Soil+ FYM (Control)], each with four replications consisting 24 beds (1×1 m) in which strawberry cultivar 'Chandler' runners were planted at a spacing of 20 x 20 cm. The study concluded that the maximum plant height (29.19 cm), number of leaves (18.31) and leaf area (135.08 cm^2) were observed under perlite + FYM

(T2) treatment. Similarly, the maximum berry yield per plant (203.32 g) and yield per hectare (50.83 t/ha) was observed under perlite + FYM (T2) treatment. So, perlite + FYM (1:1) media was most effective in improving plant growth and yield parameters than all other treatments. The studies have also revealed that perlite as a growing media was very effective in improving plant growth parameters even when it was used alone as indicated by various growth parameters such as number of leaves, root length and number of runners. The studies have conclusively proved perlite in combination with FYM to be an effective media that can be successfully used for producing elite planting material of strawberry under polyhouse. Shahzad *et al*. (2018) investigated a study on Variations in Growing Media and Plant Spacing for the Improved Production of Strawberry (*Fragaria ananassa* cv. Chandler). There were four different growth media i.e. soil + peat moss, soil + poultry waste, soil + farm yard manure and the combination of all these four media additives mixed with soil. They were used with different plant-to-plant spacing of 20, 30, and 50 cm to evaluate their effect on the fruit size, total soluble solids (TSS), fruit yield, chlorophyll content, and fruit quality (i.e., fruit color and taste) of strawberry. They concluded that peat moss amendment showed the highest fruit yield (531.56 g), chlorophyll content (12.53), TSS (8.45ºB), fruit size, and fruit quality (red color with maximum sweet taste) compared with other growing media. The research indicated that even within soil-based cultivation, the incorporation of peat moss positively influenced both the quantity and quality of strawberry fruit. Furthermore, the findings demonstrated that a plant-to-plant spacing of 20 cm yielded the best results for strawberries when cultivated in a combination of peat moss and soil. Despite the endorsement of organic soil additives in the study, their application doesn't guarantee the sustainability of organic farming practices. To make strawberry production more efficient in terms of both fruit size and quality, it is essential to ensure a better benefit-cost ratio, protect the environment, conserve resources through sustainable practices, and operate in a socially and economically responsible manner. Lakshmikanth *et al*. (2020) conducted an experiment to study the effect of different pot culture media on growth parameters, yield and economics of strawberry in vertical system. The media based treatment combination includes T1- Soil + sand + FYM (1:1:1) (Control), T2- Soil + cocopeat + vermiculite (1:1:1), T3- Soil + cocopeat + vermicompost (1:1:1), T4- Soil + cocopeat + vermiculite + vermicompost (1:1:1:1), T5- Cocopeat + vermicompost + FYM (1:1:1), T6- Cocopeat + vermiculite + vermicompost (1:1:1) and T7- Soil + vermiculite + vermicompost (1:1:1). The design followed was Completely Randomized Design (CRD) with three replications for the statistical analysis. The results revealed that the plant height (29.13 cm), number of trifoliate leaves per plant (27.80), plant spread in N-S and E-W direction (31.27 cm and 30.21 cm, respectively), number of crown per plant (4.56), area of leaf (108.26 cm^2), runners per plant (6.13), plant dry weight (38.50 g) at harvest, net income (1,22,183 / 1032 m^2) and benefit to cost ratio (2.04) was found maximum in treatment T4 i.e soil + cocopeat + vermiculite + vermicompost in 1:1:1:1 ratio on volume basis which was followed by the treatment T6 containing cocopeat + vermiculite + vermicompost in the ratio of 1:1:1. Sharma *et al*. (2022) studied the Effect of container size and growing media on growth, yield and quality of strawberry (*Fragaria* × *ananassa* Duch.). The seven treatments consisting of different growing media i.e cocopeat, perlite and vermicompost in ratio of 1:1:1, 2:1:1, 3:1:1, 4:0:1, 4:1:0 and 4:1:1 respectively, and control having soil, sand and FYM in ratio of 1:1:1 were mixed in six types of container of different sizes (24 cm × 24 cm × 14 cm, 25 cm × 21 cm× 12 cm, 20 cm ×20 cm ×10 cm, 37 cm × 23 cm × 9cm, 35 cm × 18 cm × 14 cm and 23 cm × 23 cm × 10 cm), respectively. The experiment was laid out according to factorial randomized block design with 42 treatment combination replicated thrice with two plants in each replication. At per the investigation among all the treatments, the results showed that plants raised in PVC pots with a growing media ratio of 3:1:1 (C2T3) had significantly greater height, higher growth, maximum flowering and fruiting. Also, the cost and returns were reported to be higher in polyethylene bags with a growing media ratio of 3:1:1 (C1T3) with a benefit cost ratio of 1:1.70. Thus, it is recommended that for strawberry production in open areas, PVC pots with growing media in a 3:1:1 ratio be used, as this will ensure greater success in plant establishment and provide disease-free, healthy strawberries.

CONCLUSIONS

Our review has demonstrated that growing media is an important factor limiting strawberry fruit crop production. Several growing media like cocopeat, perlite, vermiculite etc. were beneficial for increasing the growth, yield, quality and production of disease free strawberry. Moreover, Cocopeat, peat moss, and other growing media have more accessible minerals and beneficial microbial biomass, which leads to the production of humic compounds and growing media significantly augment the farmer's income by increasing the growth, yield and quality of strawberry.

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