

EFFECT OF CONTAINER SIZE AND GROWING MEDIA ON GROWTH, YIELD AND QUALITY OF STRAWBERRY (*FRAGARIA* × *ANANASSA* DUCH.)

By

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(J-19-M-656)

**A Thesis submitted to Faculty of Agriculture
in partial fulfilment of the requirements
for the degree of**

**MASTER OF SCIENCE IN AGRICULTURE
IN
HORTICULTURE (FRUIT SCIENCE)**



Division of Fruit Science

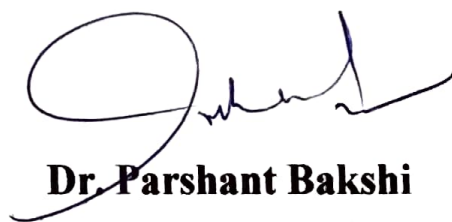
**Sher-e-Kashmir University of Agricultural Sciences & Technology of Jammu
Main Campus, Chatha, Jammu-180009**

2021

CERTIFICATE - I

This is to certify that the thesis entitled, "Effect of container size and growing media on growth, yield and quality of strawberry (*Fragaria × ananassa* Duch.)" submitted in partial fulfilment of the requirements for the degree of **Master of Science in Agriculture in Horticulture (Fruit Science)** to the Faculty of Agriculture, Sher-e-Kashmir University of Agricultural Sciences and Technology of Jammu, is original work and has similarities with published work not more than minor similarities as per UGC norms of 2018 adopted by the University. Further, the level of minor similarities has been declared after checking the manuscript with Urkund software provided by the University.

The work has been carried out by **Ms. Reetika Sharma**, under my supervision and guidance. No part of the thesis has been submitted for any other degree of diploma. It is further certified that help and assistance received during the course of thesis investigation have been duly acknowledged.



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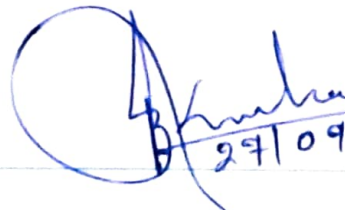
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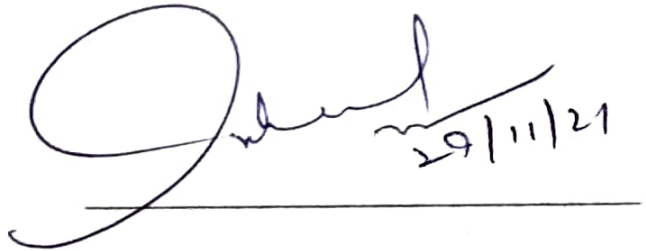

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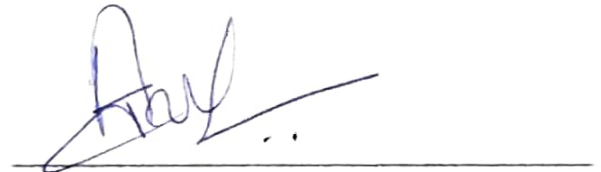
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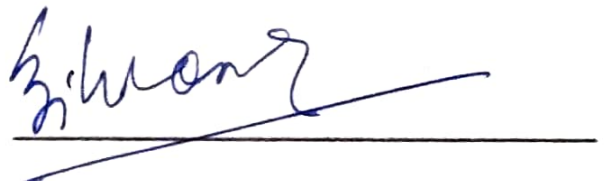
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ACKNOWLEDGEMENT

*It is indeed a special privilege to express my profound sense of reverence and indebtedness to my mentor **DR. PARSHANT BAKSHI**, Sr. Scientist, Division of Fruit Science ACHR, Udheywala, SKUAST-Jammu, for their prudent guidance, outstanding cooperation and constructive suggestions all through the investigation. I really appreciate your being so patient with me and working so hard to boost my confidence. I am indebted to his timely advice, noble counseling and for providing necessary facilities during my study. His every cordial behavior has engraved everlasting impression on my mind. It will not be an exaggeration to say that without his sincere efforts, the culmination of present research work was beyond imagination.*

*With an over whelming sense of legitimate pride and indebtedness to my Minor Advisor **DR. BHAV KUMAR SINHA**, Assistant Professor, Division of Plant Physiology, for his precious guidance, concrete suggestions, propelling encouragement and constructive comments in the course of investigation. I am obliged and indebted for his generosity, constant counsel and encouragement which induced self confidence in me. It was my pleasure and privilege to be associated with him and work under his close guidance and supervision.*

*I owe my deep and fervent thankfulness my advisory committee members **DR. KIRAN KOUR**, Assistant professor, Division of Fruit Science, **DR. AMIT JASROTIA**, Associate Professor & Head, Division of Fruit Science, and **DR. VIKAS ABROL**, Division of Soil Science and Agricultural Chemistry for their constant encouragement, valuable suggestions, guidance and advice at different phases during the course of experimentation.*

*I am very obliged to **DR. AMIT JASROTIA**, Head of the Division, **DR. NIRMAL SHARMA**, **DR. DEEP JI BHAT**, **DR. ARTI SHARMA**, and **DR. AKASH SHARMA**, **DR. RAKESH KUMAR** for their affectionate behavior, sympathetic attitude, sagacious guidance and help during the investigation.*

*I feel great pleasure in expressing my sincere gratitude to **MR. KRISHAN LAL**, FCLA, Department of Fruit Science, for providing me the lab facilities that was helpful throughout my research progress.*

*With an overwhelming and genuine sense of obligations, I avail this opportunity to express my deepest indebtedness to my seniors **MR. GURVINDER**, **MR. MANMOHAN**, for his incessant and exhilarating support.*

*I am immensely thankful to my friends particularly **SHIVAY**, **MAANIK**, **RICHA SHARMA**, **NEHA RAJ**, **PRIYANKA DAHIYA**, **SANJAY KUMAR**, **TANUJ BHARDWAJ**, **KHALID FEROZ** have rendered their immense care and support during my entire M.Sc. programme.*

*I am highly indebted to my respected father **SH. KAMAL DAS SHARMA** and mother **SMT. USHA SHARMA**, who persistently showered their silent blessing on me, patience and affection. The support provided by my younger brother **RISHABH SHARMA** during my entire study period is beyond my capacity to express in words. I convey my respect and gratitude to all my other near and dears who could not be queued to find a mention here.*

My deepest thanks to all office and field staff of the Division of Fruit Science, SKUAST-JAMMU, for their affable cooperation during the study.

Feeling from the core of my heart molded into words would not convey what I wish to express to my family. I do not find sufficient words to acknowledge my deepest sense of gratitude to my sisters, brothers and other relatives for their encouragement, patience and inspiration, which have been a benediction to me in all odds.

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ABSTRACT

Title of the Thesis : **Effect of container size and growing media on growth, yield and quality of strawberry (*Fragaria × ananassa* Duch.)**

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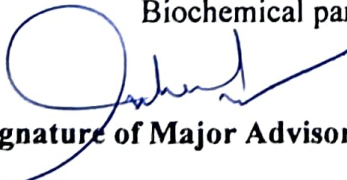
Year of award of degree : **2021**

Name of University : **Sher-e-Kashmir University of Agricultural Sciences and Technology of Jammu (J&K)**

Abstract

The present investigation entitled “Effect of container size and growing media on growth, yield and quality of strawberry (*Fragaria × ananassa* Duch.)” was carried out at Research Farm, Division of Fruit Science, Faculty of Agriculture, Sher-e-Kashmir University of Agricultural Sciences and Technology of Jammu, Main campus, Chatha during the year 2020-21. The aim of this investigation is to study the relationship between plant development, size and type of container and growing media. In this trial seven different growing media *viz.* 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 were mixed in six types of container of different dimensions of length, breadth and height (24 cm × 24 cm × 14 cm, 25 cm × 21 cm × 12 cm, 20 cm × 20 cm × 10 cm, 37 cm × 23 cm × 9 cm, 35 cm × 18 cm × 14 cm and 23 cm × 23 cm × 10 cm). The experiment was laid out according to randomized block design (factorial) with 42 treatment combinations replicated thrice. The growth, flowering, fruiting and biochemical parameters of strawberry plants such as plant height, plant spread, shoot length, crown diameter, number of runners per plant, runners length, fresh and dry weight of shoot, number of leaves per plant, leaf area, petiole length, fresh and dry weight of leaves, leaf chlorophyll content, fresh and dry weight of root and average primary and secondary length of roots, days taken to first flower, duration of flowering, number of flowers per plant, number of berries per plant, berry weight, berry breadth, berry length, total yield per plant, pH of berry, TSS, TSS: Acid ratio, total sugars, reducing sugars, non-reducing sugars and ascorbic acid were measured in this experiment. The results of the present investigation revealed that both container size and growing media had significant interaction effect ($P < 0.05$). The treatment C_2T_3 showed significantly higher growth, flowering and fruiting parameter. It was followed by C_5T_3 and lowest was found in treatment C_4T_7 i.e. control. Also, the cost and returns from the containerized strawberry was higher in C_1T_3 with benefit cost ratio of 1:1.70. On the basis of this study, it can be concluded that soilless cultivation of strawberry can be undertaken as commercial cultivation by utilizing container C_2 (PVC pot) filled with cocopeat, perlite, and vermicompost media in ratio 3:1:1 i.e. T_3 as they performed better in respect of growth, yield and quality of strawberry cv. Chandler.

Keywords: Strawberry, Container size, Growing media, Cocopeat, Perlite, Vermicompost, Biochemical parameters, Flowering parameters, Fruiting parameters.


Signature of Major Advisor


Signature of Student

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ABBREVIATIONS

%	:	Per cent
°B	:	Degree brix
°C	:	Degree Celsius
/	:	Per
2,4-D	:	2,4-dichlorophenoxy acetic acid
CD	:	Critical Difference
cm	:	Centimeter
cv.	:	Cultivar
EC	:	Electrical Conductivity
<i>et al.</i>	:	et. alia (and others)
g	:	gram
i.e.	:	that is
mm	:	Millimeter
pH	:	Negative logarithm of hydrogen ion
TSS	:	Total Soluble Solids
<i>viz.</i>	:	<i>videlicet</i> Namely

CHAPTER-1

INTRODUCTION

Urbanization in India has led to movement of people from rural areas to urban areas in search of livelihood leaving the farming sector for white-collar jobs. According to UN population Division (2005) and Wimberley *et al.* (2007), the growth of concrete landscapes into the rural areas has drastically reduced the farming lands. Urbanization has inadvertently affected the GDP of India which is largely based on the agriculture sector. The livelihood of shrinking agricultural land near urban areas is alarming and considering the need to maintain the security of food for growing populations a more systematic or intensive production needs to be taken up (Deportes *et al.*, 1995; Bryld, 2003; Bell *et al.*, 2011). The demand for agricultural products has increased with the growing population and changing dietary habits, as awareness amongst the common masses has grown.

Strawberry (*Fragaria × ananassa* Duch.) is a short-day plant for which temperatures ranging between 22°C to 25°C during the daytime and between 7°C to 13°C during night time are considered optimal (De and Bhattacharjee, 2012). Although, it is cultivated commercially in temperate climate, yet it can be grown under tropical and subtropical climatic conditions.

Strawberry plants are classified as stoloniferous, perennial, and short day forb grows predominantly in the temperate climate and is commercially propagated by runners (Finn and Strik, 2008). Its fruit contain 95 % of water and 5 % of dry matter and is also a rich source of vitamins and minerals with tasty and delicious flavour (Sharma, 2002) constituting a percentage of vitamin-C (94 mg/150 g), vitamin-A (45 IU/150 g) and proteins (1.0 g/150 g). Strawberry is known for its pleasant aroma and its fruit is used in various commercial food product industries because of its flavour, sugars, lipids content, minerals, natural source of antioxidants, and high fibre content. It is not only consumed as fresh fruit but can also used in processed foods such as ice cream, juice, jams, biscuits, and so on as a regular diet by many rising populations in the world. It also contains higher amounts of other components like flavonoids and phenolics (Hancock, 1999; Hakkinen

and Torronen, 2000). The demand for strawberry cultivation has been increasing steadily for domestic as well as exports market.

The western and southern region of India having 8000 MT of annual production from 1000 hectares of area under strawberry cultivation is a proof of the popularity that strawberry cultivation is gaining in these parts in recent times (Anonymous, 2020). In the year 2018-19, Haryana was the leading state in production of strawberry with 1650 MT, followed by states like Mizoram (1080 MT), Meghalaya, Maharashtra and Himachal Pradesh (Anonymous, 2019 a). Although the agro-climatic conditions are suitable for the cultivation of strawberry in J&K, yet the annual production is a meagre i.e 425 MT from an area of 152 hectares (Anonymous, 2019 b). This trend of low production in J&K is attributed to cultivating strawberry in open field conditions where problems like nematodes, soil borne pests, diseases and others soil limiting factors result in inferior quality planting material and fruits. The growing popularity of soilless media is due to the fact that they are free from soil borne pest, diseases and nematodes (Tehranifar *et.al.*, 2007) and also addresses the problem of poor drainage, structure, soil fumigation and salt accumulation (Vassilakakis *et al.*, 1991), thereby resulting in good vegetative growth characteristics, number of fruits and yield of better quality strawberries (Adak and Gubbuk, 2015; Shylla *et al.*, 2018).

The traditional cropping system using soil as a growing media for the production of strawberry plant poses many problems like soil borne diseases caused by *Verticillium* spp. and *Phytophthora* spp., nematodes and soil limiting factors resulting in loss of plant (Durner *et al.*, 2002). Soilless cultivation is an artificial means of providing plants with support and a reservoir for nutrients and water (Raja *et al.*, 2018). The characteristics of growing media which make it suitable for cultivation are good water and nutrient holding capacity, free from morbidic organisms and virulent compounds, providing better aeration to the root system (Johnson *et al.*, 2010). The peculiarity of organic and inorganic growing media allows better nutrient translocation which results in better growth, and development of the plant thereby ameliorating water and oxygen retention capacity (Verdonck *et al.*, 1981; Albaho *et al.*, 2008). The physiochemical properties of the growing media used plays a vital role in the growth of plants grown in container (Riaz *et al.*, 2008). In addition to

improving the yield potential of strawberry, the proportion of growing media used also augments the quality of fruit by accurate control over the distribution of water, nutrients, pH, and root zonal temperature (Olympios, 1993).

The most commonly used media included gravel, coir, peat, vermiculite, perlite, cocopeat, vermicompost, etc. (Celikel, 1999). For plants to be grown successfully in a container it is essential to select a specific media. The physiochemical properties of media largely affects the growth of the plant (Robbins and Evans, 2001; Wilkerson, 2002 and Riaz *et al.*, 2010). Therefore, the composition of the growth media either alone or in combination is a very important factor to be taken into consideration (Ingram *et al.*, 2003). Some of the important physical and chemical properties of growing media are pH, bulk density, pore space, distribution of the particle size, water retention capacity and soluble salts. They have been substituted by soilless protected cultivation with nursery facilities to produce container plants for the expanding high-density annual system of plasticulture. The occurrence of pest and diseases in soil culture in the traditional matted row culture is problem seen in protected areas (Gul *et al.*, 2005) in contrast to the modern strawberry cultivation finds a place for plasticulture system therefore provides an opportunity to extend harvesting season as well as make fruit harvesting more efficient and supports out of season strawberry production and increase in yield with less biotic stress (Takeda, 1999).

Roots rely upon plant aerial parts and plant aerial parts rely on the roots for water uptake, nutrients, support, and hormones. The balance between roots and shoots can be disturbed when the root system is restricted in a small rooting volume and resulting in negative effects on plant growth. The use of substrates with different proportions in pots of different sizes significantly influences the canopy, growth, yield and quality indicators. This is due to the fact that larger pots impacts numerous other characteristics related to photosynthetic matter. Thus, enhancing source-sink relationship and their influence on yield development and nutritional quality (Kasai *et al.*, 2012). Container size and shape interact with plant biomass and its allocation (Carlson and Endean 1976; Poorter *et al.*, 2012), and therefore have consequences on-field performance. Biological activity and growth parameters of the plants are also significantly in affected by the type of pot used (Manole *et al.*, 2008). Significant influence on the growth yield and quality of different

fruit crops is seen as a result of better development of root, which is influenced by the size and type of pot used. (Manole *et al.*, 2008; Krezel and Kolota, 2009). Thus, strawberry being a shallow-rooted and small-statured plant can be cultivated in containers to meet the increasing demand for strawberries throughout the year and also meeting the nutritional security for people living in urban and peri-urban areas.

The present study entitled “Effect of container size and growing media on growth, yield and quality of strawberry (*Fragaria × ananassa* Duch.)” will be undertaken with the following objectives:

- To study the effect of container size and growing media on growth, yield and quality of strawberry.
- To standardize the container size and growing media for higher strawberry productivity.
- To work out the economics of best treatment.

CHAPTER-2

REVIEW OF LITERATURE

Strawberry is one of the most important stoloniferous perennial forb belonging to the family Rosaceae, widely distributed due to its expansive environmental adaptations. The suitable soilless growing media and ideal size of container plays a vital role in the production of healthy and vigorous plants. Generally, soilless plant production has been practiced where no suitable soil exists, so it has been adjusted to be the most critical factor determining the quality of strawberry, acting as a reservoir for nutrients and moisture. The growing media not only improves the yield but also ameliorates the quality of the fruits by precise control over the distribution of water, nutrients, root zonal temperature, and pH (Olympios, 1993). An ideal type of pot is significantly important for the root growth, which results in significant influence on growth, yield, quality, and canopy indicators in different crops (Manole *et al.*, 2008; Krezel and Kolota, 2009). Keeping in view, the research title entitled “Effect of container size and growing media on growth, yield and quality of strawberry (*Fragaria × ananassa* Duch.)” has been planned. The literature pertaining to the above said problem reviewed in this chapter.

2.1 Effect of growing media on growth, yield and quality of strawberry

2.1.1 Plant Growth

Strawberry being a liable plant and a number of organisms act on almost all parts including crown, leaves, roots and fruits and various fungi in association with nematodes cause diseases, reduce the yield potential and increase the mortality. To eradicate the soil borne diseases and pest, the growing media can be used to surrogate the soil (De-Rijck and Schrevens, 1998). The soilless cultivation may be a productive choice as compared to soil-based cultivation (Albaho *et al.*, 2008) and making use of local materials as growing media with determined physical and chemical properties (Ortega *et al.*, 1996), which exhibit direct and indirect effects on plant growth and production (Verdonck *et al.*, 1981). Cocopeat being the commonly used organic substrate in India has high water holding and cation exchange capacity, whereas, perlite provides the required porosity to the media.

The application of vermicompost in soilless culture increased growth and yield of strawberry (Arancon *et al.*, 2004) because it contains available forms of nutrients such as nitrogen, exchangeable phosphorus, potassium, calcium, and magnesium (Edwards and Burrows, 1988) besides micronutrients. The suitable ratios of the growing media in strawberry not only improves the yield but also ameliorates the quality of the fruits by precise control over the distribution of water, nutrients, root zonal temperature and pH (Olympios, 1993).

Sirin *et al.* (1999) performed an experiment on the effect of pot size and growing media on growth of tomato in soilless culture and reported that the cocopeat gave the maximum marketable number of fruit per plant (56.2%) and the maximum marketable yield per plant (445.6 g) and also concluded that cocopeat is recommended as best growing media for tomato cultivation.

Grassotti *et al.* (2003) conducted a research trial on the effects of growing media and planting time on lily hybrids in soilless culture and stated that the earliest time of flowering (154.78 days) and the maximum plant height (120.82 cm) in the 'Siberia' variety occurred in combination of peat along with pumice, whereas the highest number of flowers (7 and 5.67) and the maximum stem weight (266.13 g and 353.91 g) were recorded in Siberia and Vespucci respectively in cocopeat.

Arancon *et al.* (2004) carried a study on the influence of vermicompost on growth and yield of field strawberries and noted that an applications of vermicompost which resulted in increases of up to 37 % in leaf areas, 37 % in shoot biomass, 40 % in flower number, 36 per cent in numbers of plant runners and 35 per cent in marketable fruit weights.

Ericisli *et al.* (2005) studied the influence of growing media on the growth of strawberry cvs. Camarosa and Fern and revealed that the maximum number of primary roots per plant (30.83 in Fern and 26.82 in Camarosa) was found in perlite growing media, the maximum length of roots (49.21 cm in Fern and 44.42 cm in Camarosa) was observed in finpeat along with perlite growing medium and the number of crowns per runner (3.28 in Fern and 3.86 in Camarosa) was noted in peat growing medium.

Fascella and Zizzo (2005) studied the influence of growing media on yield and quality of soilless cultivated rose and recorded that the perlite and coir dust was found to be best media in respect of maximum flower number (17.7 stems per plant) and the maximum length of stem (65 cm).

Bartczak *et al.* (2007) conducted an experiment on effect of growing media on vegetative quality of strawberry plants produced by a soilless cultivation and observed that the maximum number of leaves per plant (11.8) was found in rockwool growing media as compared to control.

Ghazvini *et al.* (2007) performed an experiment on the effect of combinations of clinoptilolitic-zeolite and perlite on the yield and quality of strawberry in soilless culture and found that the plants grown in perlite with zeolite combination ratio of 75:25 gave maximum number of flowers (41) and minimum was reported in 100 percent zeolite (25.78).

Tehranifar *et al.* (2007) evaluated the effect of various soilless media on qualitative and quantitative characteristics of strawberry cultivars under soilless cultivation and reported that the maximum petiole length (96.06 mm) was found in 100 per cent cocopeat in comparison to the 100 per cent sand (89.21 mm).

Jankauskiene and Brazaityte (2008) conducted a research trial on the influence of transplant age on the earliness of yield and productivity of short-fruit cucumbers and the results demonstrated that the height of plant (39.38 cm), leaf number (5.80) and leaf area (598.90 cm²) was highest in peat and zeolite with combination ratio of 1:1.

Singh *et al.* (2008) performed an experiment on the influence of vermicompost on growth physiological disorders, yield and quality of strawberry and revealed that the application of vermicompost increased plant spread (10.7%), leaf area (23.1%) and dry matter (20.7%), and total fruit yield (32.7%) in strawberry plant.

Treder (2008) carried out an experiment on the influence of cocopeat and fertilization on the growth and flowering of oriental lily and his experimental observations revealed that earlier flowering, maximum fresh weight of flower buds (32.5 g per plant),

better root system and lower bulb depletion between planting and flowering gave better result in cocopeat as compared to control.

Jafarnia *et al.* (2010) studied the impact of substrate and variety on quality and quantity characteristics of strawberry production in vertical hydroponics system and found that the highest number of runners (0.73) was reported in 100 percent perlite, the highest number of crown (1.86) was occurred in 60 percent perlite with 40 percent peat moss and the highest Total soluble solid was noted in 60 percent perlite with 40 percent of peat moss and 80 percent perlite with 20 percent peat moss, respectively.

Ors and Anapali (2010) studied the influence of soil addition on physical properties of perlite based growing media and strawberry cv. Camarosa and revealed that the maximum average number of leaf number (7.36), leaf area (24.98 cm²), length of the most developed roots (30.35 cm) and increase of fresh root weight (54.80 g) was observed in 50 percent soil with 50 percent perlite media followed by 40 percent soil with 60 percent perlite media.

Ayesha *et al.* (2011) carried out an experiment on the influence of various growing media on the quality of fruit and reproductive growth parameters of strawberry and stated that average flower number per truss (6.33), average flower number (96), size of flower (1.90 cm), average fruit set number (16.00), average fruit number (72.96), and average size of fruit (3.01cm) and total sugars (15.22%) were recorded in coconut coir dust based medium.

Khalaj *et al.* (2011) conducted a studied on the impact of different growing media on the growth and yield of gerbera (*Gerbera jamesonii* L.) and found that the mixture of 25 percent perlite, 70 percent peat and 5 percent expanded clay produced highest number of flower (10.33 per plant) as compared to control.

Singh *et al.* (2011) carried a research trial on standardization of growing medium in pots for anthurium (*Anthurium andreanum* L.) cv. Flame. The results demonstrated that the highest leaf area (229.11 cm²), petiole length (21.31 cm), minimum days to flowering (260.47), stalk length (36.16 cm), spathe length and width (8.5 and 8.08 cm, respectively) and number of flowers per plant (6.07) in treatment comprising of saw dust , brick pieces

, wooden charcoal, soil, sand and FYM (2:1:1: 1: 1:1) and the highest number of leaves per plant (7.40), longest inflorescence longevity (63.53 days) and highest number of suckers per plant (5.00) were noted in treatment combinations comprising of saw dust, wooden charcoal, soil, sand and FYM (2:1:1: 1: 1).

Ahmad *et al.* (2012) carried out an experiment on effects of various growing substrates with combinations of soil, silt, sand, press mud (PM) and rice hulls (RH) on plant growth, yield and quality of rose (*Rosa hybrida* L.) cvs. Kardinal, Anjlique and Gold Medal and results demonstrated that the maximum height of plant (52.5 cm), leaf number per branch (15.9) and leaf area (65 cm²) was observed when plants were grown in a medium containing combination of Soil + PM + RH followed by Silt + PM and PM + RH.

Ameri *et al.* (2012) conducted a study on the influence of soilless substrate and cultivar on growth characteristics of strawberry in soilless cultivation system and resulted that the substrate comprising of 50 percent coco peat and 50 percent perlite gave maximum leaf area (54.30 cm²), length of petiole (13.18 cm), number of runners (2.16) and total biomass (20.50g) was found in Camarosa cultivar of strawberry.

Hesami *et al.* (2012) carried out an experiment on date-peat as an alternative in hydroponic strawberry production and noted that the maximum fruit yield (88.88 g), fruit number (10.75), chlorophyll content (48.65) and leaf area (201.4 cm²) was observed in two parts of perlite, one part of date-peat and one part of coco-peat substrate.

Mamatha and Shivananda (2012) evaluated the growth and yield attributes of *Coleus vettiveroides* as influenced by different levels of fertilizers and observed that the maximum plant height (83 cm) occurred in 25 percent of sand and 75 percent of soil whereas maximum number of leaves per plant (108), number of branches per plant (14), leaf weight per plant (236 g), stem weight per plant (440 g) and primary root weight per plant (45 g) was recorded in pot mixture of 50 percent of sand, 50 percent of soil and 10t/ha of FYM.

Yadav *et al.* (2012) carried a study on the impact of media on growth and development of acid lime seedling and found that the media comprising of soil, sand, vermicompost, vermiculite and cocopeat with ratio of 1:1:1:1:1 gave better results in

respect of seedling height (13.75 cm), leaf number per seedling (22.46), diameter of stem (3.35 mm), fresh weight of seedling (2.77 g) and dry weight of seedling (1.18 g) among all combinations of media.

Khalid *et al.* (2013) carried out an experiment on the influence of organic amendments on vegetative growth, fruit and yield quality of strawberry plant and concluded that the treatment combination comprising of soil, silt and FYM showed maximum height of plant (15.21 cm), diameter of crown (1.47 cm), canopy spread (20.37 cm), fresh weight of plant (10.71 g), runners number per plant (2), total flower number (58), total fruit number (42), size of fruit (3.04 cm), fruit weight per berry (8.82 g) while treatment combination comprising of soil, silt, and vermicompost reported that the maximum fresh weight of leaf (0.92 g), leaf number (6.67), leaf area (43.07 cm²/sup 2/) and days required for first bloom (96.67).

Patel *et al.* (2013) studied the effect of different chemical fertilizers sprays, growing media and growing structures on growth and development of acid lime seedlings cv. Kagzi. and revealed that the better performance in media containing soil, cocopeat and vermicompost with ratio of 1:1:1 noted maximum plant height (62.5 cm), root length (32.2 cm), number of leaves (37.8) and total dry weight per plant (0.56 g).

Tariq *et al.* (2013) evaluated the impact of growing media on growth and yield of strawberry and observed that the peat moss showed best results on plant height, canopy size and leaf area of strawberry in a greenhouse as compared to all other substrates and stated that the mixture of sand, silt and FYM with ratio of 1:1:1 gave a significant increment in vegetative growth which resulted in early flowering with more number of flowers per plant (25.32) in strawberry plants.

Asghari (2014) conducted a trial on the effect of growth medium and nutrient solution on phytochemical and nutritional characteristics of strawberry (*Fragaria × ananassa* Duch.) and concluded that highest content of total soluble solids (16.01 °Brix) was observed in a medium with equal percentage of vermicompost (15%) and golja (15%) plus 10 percent cocopeat and 60 percent perlite and the medium with 20 percent

vermicompost and 10 percent golja plus 10 percent cocopeat and 60 percent perlite showed highest acidity (0.31 mg per 100 g).

Kumar *et al.* (2014) studied the influence of growth conditions on yield, quality and disease of strawberry (*Fragaria x ananassa* Duch.) var. Ofra and Chandler under mid-hills of Sikkim Himalaya and reported that the maximum survival per cent (83.67 %), collar girth (3.78 cm), height of sapling (62.25 cm), leaf number (7.33) was found in growing media with combination ratio of soil + vermicompost (2:1) + NPK (5g/ sapling).

Kumawat *et al.* (2014) conducted an experiment on seed germination and seedling growth of papaya (*Carica papaya* L.) cv. Coorg Honey Dew. They revealed that the treatment combination of soil, compost and cocopeat with ratio of 1:1:1 with GA- 150 ppm is better for early as well as higher percentage of germination (83.33 %), pronounced shoot growth (14.27 cm) and growth of tap root (9.15 cm) in papaya seedlings.

Rostami *et al.* (2014) carried a study on application of culture media (date palm waste) for strawberry and its effect on some growth indicators and yield components and reported maximum plant height (18.63 cm) was obtained under date palm culture media, which was not significantly different from cocopeat and perlite cultivation substrate.

Singh *et al.* (2015) conducted an experiment on the impact of vermicompost on strawberry growth, flowering and yield and the study revealed that the application of vermicompost with combination of azotobacter and phosphorous solubilising bacteria alongwith arbuscular mycorrhiza gave maximum plant height (20.26 cm), spread of plant (25.64 cm), leaf number (54.30) and maximum leaf area (97.87 cm²), whereas all the growth characters were observed to be minimum in control.

Dhaker *et al.* (2016) carried out a study on the influence of growing media and various containers on papaya variety Pusa Nanha and resulted that soil, FYM, sand, cocopeat, and vermicompost with combination ratio of 1:1:1:1:1 gave better performance in respect of seedling height (12.30 cm), leaf number per seedling (10.92), area of leaves (28.65 cm), leaf fresh weight (3.88 g), dry weight of leaves (0.43 g), primary root diameter (2.45 mm), index of seedling vigor (1683.52) and root and shoot ratio (0.14).

Sharma and Godara (2016) carried out a study on impact of soilless growing media and container sizes on shoot growth of strawberry cv. Sweet Charlie. and observed that maximum leaf number (10.45 and 15.42), length of petiole (9.19 cm and 9.18 cm), plant spread (27.43 cm and 30.24 cm), height of plant (15.26 cm and 16.27 cm) and diameter of crown (17.44 mm and 18.10 mm) were found in (cocopeat + perlite + vermicompost, 3:1:1), whereas, minimum growth was observed in control (soil).

Raja *et al.* (2018) studied the influence of substrates on different growth and quality of strawberry cv. Chandler under greenhouse conditions and reported that cocopeat, vermiculite with combination ratio of 25:75 showed better performance in respect of maximum petiole length (16.77 cm), diameter of crown (2.10 cm), canopy spread (42.75 cm), fresh weight of shoot (17.16 g), dry weight of shoot (4.36 g), fresh weight of root (16.53 g), dry weight (5.13 g) of root, leaf area (1542 cm²), number of leaves (17), weight of fruit (10.76 g), diameter of fruit (27.48 mm), length of fruit (29.89 mm) whereas the treatment consisting of cocopeat, perlite, and vermiculite with combination ratio of 50:25:25 produced maximum plant height (28.36 cm), length of shoot (23.13 cm), length of root (32.40 cm), TSS (10.8 °B) and lowest titratable acidity (0.86%).

Shahzad *et al.* (2018) conducted a study on variations in growing media for the improved production of strawberry cv. Chandler and revealed that peat moss amendment reported the maximum yield (531.56 g), leaf chlorophyll content (12.53) and TSS (8.45).

Thakur and Shylla (2018) carried out a study on impact of different growing media on growth and yield of strawberry cv. Chandler under protected conditions and reported that perlite as a growing media shows maximum number of leaves (18.32), root length (18.91 cm) and number of runners (40.25) significantly.

Lakshmikanth *et al.* (2020) conducted a study on development strawberry cv. 'Winter dawn', in naturally ventilated polyhouse with seven different substrate combination of soil, sand, farmyard manure, cocopeat, vermicompost, and vermiculite under vertical faring system. They revealed that the highest plant height (29.13 cm), number of trifoliolate leaves per plant (27.80), plant spread in North- South and East- West direction (31.27 cm and 30.21 cm, respectively), crown number per plant (4.56), leaf area

(108.26 cm²), runners per plant (6.13), plant dry weight (38.50 g) at harvest, net income (₹ 1,22,183 / 1032 m²) and benefit to cost ratio (2.04) was found in treatment T₄ i.e Soil + cocopeat + vermiculite + vermicompost in 1:1:1:1 ratio on volume basis followed by the treatment T₆ i.e cocopeat + vermiculite + vermicompost in the ratio of 1:1:1.

2.1.2 Fruit Yield

Linardakis and Manios (1991) examined a study on hydroponic culture of strawberries and revealed that strawberries grown on substrate composed of perlite 80 percent + peat 20 percent produced higher yield (250 g/plant) than those grown on the other substrates.

Gul *et al.* (1993) carried a research trial on the influence of growing media on tomato yield and its quality and observed maximum yield in tomato when perlite with combination of sand was used as growing media, while minimum was obtained in growing media which consisting only perlite or in combination with sand, peat rock or sawdust.

Alan *et al.* (1994) studied the effect of growing media on growth, yield and quality of tomato and reported maximum marketable yield was observed when a mixture of 80 percent pumice + 10 percent perlite + 10 percent peat medium used as growing media and gave about 30 percent more product in comparison to the soil as control.

Bohme *et al.* (2001) conducted an experiment on effect of different substrates and mineral as well as organic nutrition on the growth of cucumber in closed substrate system and reported maximum yield was found in plants when were grown in perlite or rockwool substrate as compared to coconut fibre.

Tuzel *et al.* (2001) evaluated the effect of different substrates and substrate volumes on quality and yield of tomato under greenhouse conditions and concluded that the plants grown in perlite or with peat combination gave maximum total yield of tomato than from the combination of pumice, volcanic ash, pumice with peat and volcanic ash with peat medium.

Ebrahimi *et al.* (2012) carried a study on growth and yield of strawberries under different concentrations of potassium under hydroponic system and observed that when

strawberry plants grown in cocopeat with perlite combination used as a growing media gave the highest berry yield (921.84 g per plant) as compared to soil (control).

Tehranifar and Sarsaefi (2002) conducted a study on strawberry growing in Iran and came to the conclusion that 40 percent of cocopeat combined with 60 percent of perlite medium obtained the maximum yield per plant and also revealed that substrates with peat or cocopeat gave higher yield than in substrates without peat or cocopeat.

Inden and Torres (2004) studied on influence of substrates on the growth and quality of tomatoes and revealed that maximum total yield was obtained when tomato was grown in perlite with rice hull as compared to rockwool, perlite, and carbonised rice hull, cypress bark and coconut coir.

Mousavi (2004) studied the effect of cultivation beds and different nutrient solutions on quantitative and qualitative features of pepper (*Capsicum annum*) in cultivation without soil system and reported that the substrates comprising of 50-75 percent perlite gave maximum yield in capsicum.

Caso *et al.* (2009) conducted an experiment on the impact of different substrates on the growth and yield of strawberry cv. Chandler under column system and found that the maximum yield (496.73 g plant⁻¹) were obtained in rice husks (100%) as compared to control.

KacjanMarsi and Jakse (2010) was conducted an experiment on an effect of different soilless substrate on yield of grafted and ungrafted cucumber (*Cucumis sativus* L.) and reported that the growth of cucumber showed better performance in perlite with marketable yield 7.9 kg plant⁻¹.

Hesami *et al.* (2012) carried out an experiment on date-peat as an alternative in hydroponic strawberry production and suggested that the better amalgamation was took when a amalgamation of two parts of perlite, one part of date-peat and one part of cocopeat resulted in increased fruit yield (88.88g).

Haghighi *et al.* (2016) evaluated the effect of peat, perlite and vermicompost on tomato growth and yield under hydroponic system and observed that the highest fruit yield

per plant was obtained in tomato plants grown in substrate comprising of compost, vermiculite, and perlite (C25:V25:PR50) as compared to control.

Godara and Sharma (2016) conducted an experiment on the impact of different growing systems on roots of strawberry under green house and revealed that the plants grown in treatment combination comprising of cocopeat, perlite and vermicompost (3:1:1) gave highest yield (339.43 g and 345.01 g) whereas, lowest yield (143.93 g and 171.54 g) per plant was recorded from soil (control).

Shahzad *et al.* (2018) conducted an experiment to evaluate the impact of organic growing media on the growth and yield of strawberry cv. Chandler and reported that peat moss amendment showed the maximum fruit yield (531.56 g) in strawberry.

Lakshmikanth *et al.* (2020) conducted a study on development of above ground plant parts of strawberry cv. 'Winter dawn', in naturally ventilated polyhouse with seven different substrate combination consisting of soil, sand, farmyard manure, cocopeat, vermicompost and vermiculite under vertical faring system and reported that the maximum yield per plant (391.24 g) was found in treatment combination comprising of soil, cocopeat, vermiculite and vermicompost in combination ratio of 1:1:1:1 on volume basis followed by the treatment combination comprising of cocopeat, vermiculite and vermicompost in combination ratio of 1:1:1.

2.1.3 Fruit Quality

Joshi (2003) studied the effect of growing media on growth, yield and quality of strawberry cv. Chandler and revealed that the maximum reducing sugar (5.56 %), non-reducing sugar (1.86%), total sugar content (7.47%), TSS/Acid ratio (12.58) was recorded in strawberry grown in combination of soil, FYM, and vermiculite than in control.

Tariq *et al.* (2003) studied the influence of growing media on growth and yield of strawberry and reported that perlite with combination of zeolite in 3:1 ratio showed the maximum concentration of total soluble solids as compared to control.

Inden and Torres (2004) examined the comparison between four different growing substrates and control on growth and quality of tomatoes and reported that highest total soluble solids was reported in fruits which were grown in cocopeat.

Ghazvani *et al.* (2007) conducted a trial on the impact of amalgamation of clinoptilolitic-zeolite and perlite on the yield and quality of strawberry under soilless cultivation and evaluated on his studies that perlite alone gave maximum TSS (7.87 °Brix), TSS: Acid ratio (10.57) and with combination of zeolite (1:3) recorded the highest titratable acidity (1.04 mg/100g FW).

Tehranifar *et al.* (2007) carried out a study on the impacts of different substrates on strawberry cultivars under soilless culture and revealed in that maximum soluble solid percentage in the berries was reported from 100 per cent perlite growing media as compared to different media mixtures.

Ullah *et al.* (2008) studied the effects of organic manures and chemical fertilizers on the yield of brinjal and soil properties and reported that leaf manure based growing media gave better results in producing maximum branching (20.1) with the highest number fruits/plant (15.2), fruit length (14.1 cm) and fruit diameter (4.3 cm) which might be due to its capacity to give essential micronutrients to the plants and also improved the quality of fruit crops.

Fandi *et al.* (2008) conducted a study on effect of substrate on yield and fruit quality of tomato under soilless culture and observed that maximum total soluble solids was found in tuff or sand growing medium as compared to fruits growing in soil.

Tulipani *et al.* (2008) carried out an experiment on impact of different growing media on quality of strawberry fruits of two cultivars viz., Camarosa and Selva under protected conditions and reported highest titratable acidity in Camarosa and highest total soluble solids in Selva cultivar was noted in vermiculite with combination of perlite and cocopeat.

Jafarnia *et al.* (2010) carried out a study on the influence of substrate on strawberry production under vertical hydroponics system and resulted a significantly maximum per cent of total soluble solid from the combination of perlite and peat moss as compared to 100 per cent perlite alone in strawberry.

Ayesha *et al.* (2011) conducted a trial by on the effect of growing media on the quality of strawberry cv. Chandler under a poly tunnel system and observed that soil with

combination of silt and FYM gave maximum total soluble solids (6.26%) of the berries. Also significant impact on total sugars (15.92 %) was recorded by soil in combination of silt and coconut coir dust (1:1:1).

Ghehsareh *et al.* (2011) conducted a study on perlite as growth substrates on some tomato growing indicators and concluded that the greenhouse tomato grown in perlite, date-palm peat and cocopeat growing media obtained maximum amount of total soluble solids (3.7 °Brix).

Hassan *et al.* (2011) studied the effect of various organic substrate culture and container types on productivity and fruit quality of strawberry (*Fragaria × ananassa*) cv. Festival and reported that the highest titratable acidity observed in using peanut husk as growing media for strawberry cv. Festival, whereas maximum total soluble solids were recorded in strawberry fruits were grown in coconut husks.

Ebrahimi *et al.* (2012) evaluated that the growth and yield of strawberries under different concentrations of potassium in hydroponic system and noted the highest mean total soluble solids (1.08 °Brix) in strawberry fruits which were grown in peat with combination of sand and perlite growing media.

Ameri *et al.* (2012) carried out a study on the impact of substrate on growth characteristic of strawberry cv. Selva under soilless cultivation and found that by using vermicompost in combination with perlite and cocopeat (5:45:50) gave maximum total soluble solids.

Hesami *et al.* (2012) studied the effect of date-peat as an alternative in hydroponic strawberry production and concluded that application of date-peat with combination ratio of cocopeat i.e 3:1 or with combination ratio of 1:3 led to an increment in the per cent of total soluble solids of strawberry.

Asghari (2014) conducted a research trial on the effect of growth medium and nutrient solution on phytochemical and nutritional characteristics of strawberry (*Fragaria × ananassa* Duch.) and resulted that production of berries of strawberry in a media consisting of vermicompost (15%) and golja (15%) plus 10 percent cocopeat and 60 percent perlite had maximum content of total soluble solids.

Haghighi *et al.* (2016) studied the impact of solid waste compost, peat, perlite and vermicompost on fruit quality of tomato in a hydroponic system and observed the maximum total soluble solids in fruits of tomato which were grown in control:vermiculite:perlite (C25:V25:PR50).

2.2 Effect of container size on growth, yield and quality of strawberry.

Roots rely upon plant aerial portions for photosynthates and plant aerial portion rely on the roots for water, nutrients, support and hormones. The restricted rooting volume can negatively affect the growth of shoot and roots. Thus, impacting overall growth of the plant. Pots of varying sizes along with definite substrate volume impacts the growth, canopy and yield of plants significantly. As larger pot size positively affects the growth characteristics pertaining to photosynthetic matter, particularly the growth of sink organs (Kasai *et al.*, 2012). Container size and shape interacts with plant biomass and its allocation (Carlson and Endean 1976; Poorter *et al.*, 2012), and therefore has consequences on field performance. Pot type and size significantly influences the biological activity in substrate and growth parameters of the plants (Manole *et al.*, 2008). The type of pot and its size has a considerable effect on root development, which in turn impacts the growth yield and quality in various crops (Manole *et al.*, 2008; Krezel and Kolota, 2009). Thus, strawberry being a shallow rooted plant can be cultivated in containers to meet the increasing demand for strawberries throughout the year and also meeting the nutritional security.

2.2.1 Growth

Paroussi *et al.* (1995) carried a study on precocity, productivity of plant and quality of strawberry plants grown under soil and soilless culture system and concluded that when strawberry grown hydroponically in vertical plastic black bags filled with perlite gave the maximum number of leaves, fresh and dry plant weight as compared to the plastic white container which consists of soil mixture.

Artetxe *et al.* (1997) conducted a study on effects of container size and substrates on growth of *Hydrangea macrophylla* and revealed that different container size influenced the growth and gave better production as well as flowering in *Hydrangea macrophylla*.

Rao and Venkaiah (2001) examined the study on root trainer vs. stump planting of teak and found that the root trainer seedlings had gave the highest height and girth at ground level.

Zhang and Bravdo (2001) carried a study on the effect of root restriction on the growth of wine grape and reported the maximum dry weight of root in 50 litre pot as compared to 20 and 10 litre pot respectively. They concluded that above plant growth from the ground was also affected negatively by root restriction.

Annapurna *et al.* (2004) conducted an experiment on the effect of type of container and size on the growth and quality of seedlings of Indian sandalwood (*Santalum album* L.) and reported that 600 ml size gave better performance in terms of seedling height (20.4 cm), collar diameter (3mm), dry weight of shoot (1.66 g), total dry weight (3.06 g) and dry weight of root (1.41 g).

Fatema (2005) carried out an experiment on the effect of different polybag size on the growth of kalokoroi (*Albizia lebbek*), raintree (*Albizia saman*) and Ipil-ipil (*Leucaena leucocephala*) seedlings and resulted that 23 cm x 15 cm sized polybag produced significant influence on different growth parameters of the seedling than other treatments.

Araujo *et al.* (2006) evaluated the effect of containers on the development of papaya seedlings (*Carica papaya* L.) cv. Sunrise solo and concluded that papaya seedlings produced in the polyethylene bag having dimension of 20 x 32 cm was reported superior in all characters of seedlings.

Barad (2006) studied the influence of media and root trainer on growth of rayan seedlings and observed that root trainer size of 300 cc gave better performance in respect of seedling height (7.98 cm), collar diameter (2.06mm), number of leaves (6.85), total biomass (1.29g) and root length (7.65).

Manole *et al.* (2008) studied that the influence of pot types on the biological activity of the growing media and reported that approximately 1.2 times higher root and shoot weights of cabbage was observed in the plastic and jiffy pots as compared to the other pots.

Berko *et al.* (2011) studied the influence of polythene bag size on cashew (*Anacardium occidentale*) seedlings and revealed that seedlings in polythene bag of sizes

5.5x7 inches and 7x10 inches were superior to the polythene bag sizes of sizes 4x6 inches, 4x7 inches, 5.5x6 inches and 5x7 inches seedlings both at emergence and seedling growth and it was also evaluated that good performance was observed with bag size of 5.5 × 7 inches.

Ferdousee *et al.* (2011) investigated the growth of *Leucaena leucocephala* seedlings grown in polybag and found that the seedlings raised in polybags of size 23 × 15 cm reported better results in respect to germination and other growth parameters while, the root-shoot ratio was maximum in root trainer as compared to other treatments.

Geply *et al.* (2011) conducted a trial on the effect of different pot sizes and growth media on the agronomic performance of *Jatropha curcas* and reported longest height was observed in 5 cm pot size.

Al-Menaie *et al.* (2012) studied the effect of pot size on plant growth and multiplication of water lilies (*Nymphaea* sp.) and concluded that growth and multiplication of water lily was found better in rectangular pots of size 50 h × 45 w × 22 d cm.

Karimi *et al.* (2013) studied the impact of different soilless culture systems on growth, yield and quality of strawberry cv. Festival and revealed that the maximum leaf area (2478.66 cm²), crown diameter (33.75 cm), fruit fresh weight (60.97 g) and root fresh weight (16.50 g), shoot dry weight (21.10 g) and root dry weight (5.74 g), TSS (10.61⁰B), number of flowers (37.00) and number of fruits (22.66) was obtained in plants grown in open trough.

Massetani *et al.* (2014) conducted a study to find out the effect of rooting time, pot size and fertigation technique on strawberry plant architecture by using two different types of pot sizes for the cultivation of “Capri” and “Elsanta” cultivars of strawberry and reported that the Elsanta plants in tray pot (250 cm³) gave better vegetative growth, with the formation of a maximum number of runners per plant (4.3) and suggested that pot size played major role in controlling plant growth.

Godara and Sharma (2016) conducted an experiment on the effect of different growing media and container size in strawberry under Hi-Tech green house. They used

three types of containers i.e polyethylene bags, PVC pots and earthen pots in dimensions of 16 cm × 16 cm, 20 cm × 20 cm and 15 cm × 25 cm, respectively. They found that the best performance was observed in PVC pots in terms of growth of strawberry.

2.2.2 Yield and quality

Weston *et al.* (1986) conducted a study on the effect of container size on growth and yield of tomato (*Lycopersicon esculentum* Mill.) transplants and resulted that the large root cell size gave the maximum early fruit yields, and the maximum marketable weight of fruit.

Bahuguna and Lal (1990) conducted a study on the effects of environment and different soil mixtures on germination of *Acacia nilotica* at nursery stage and reported polybags with dimension of 22 cm x 15 cm or wooden boxes with dimension of 52 cm × 5221 cm gave better percentage of germination *Acacia nilotica* at nursery stage.

Dijkstra *et al.* (1993) conducted a study on impacts of density of planting and peat volume on production of strawberry under bag and bucket culture system and resulted that optimum yields from 'Elsanta' strawberry obtained from a 6 liter plastic pots or 8 liter plastic bags in an unheated tunnel.

Takeda (2000) studied out-of-season greenhouse strawberry production in soilless substrate and reported that better yields occurred from 'Chandler' and 'Camarosa' strawberry plants which were grown in a greenhouse by using different volumes of pots i.e 7.6 liter plastic pots (5 plants/ pot and 1.5 l/ plant) or 2.8 liter interlocking polystyrene pots (4 plants/ pots and 0.7 l/ pot) filled with peat mix growing media which resulted similar performance.

Ginwal *et al.* (2001) examined a study on selection of proper potting mixtures for raising *Acacia nilotica* seedlings under root trainer seedling production system and noted that the growth performance of *Acacia nilotica* seedlings raised in 300 cc Hiko pots gave better performance in respect of yield and quality in nursery as well as in the field condition.

Krezel and Kolota (2009) carried a research work on the impact of pots size on growth and yield of chinese cabbage and results demonstrated that the chinese cabbage seedling grown in pots with a diameter of 55 mm gave maximum marketable yield, whereas yield of cabbage decreased in pots with smaller diameter and also resulted in formation of smaller heads.

2.3 Economics

Engindeniz and Gul (2009) conducted a study on comparative analysis of soilless and soil based cucumber production under greenhouse and revealed that net return of soilless production (1.84 Euro per m²) was higher than soil-based production (1.48 Euro per m²). This was due to yield as well as gross revenue were higher than soil-based production of cucumber and suggested that the soilless cucumber production is an economically viable as compared to soil-based cucumber production.

Kumar *et al.* (2011) carried a study to know the benefit cost ratio of cv. Chandler and resulted in higher benefit cost ratio of 1:2.26 which suggested that cv. Chandler as a variety is economically viable.

Lakshmikanth *et al.* (2020) studied on the economics of strawberry cultivation in vertical farming system with different pot culture media and reported that the maximum net income (₹ 122183 per 1032 m²) was obtained by treatment T₄ which consists soil, cocopeat, vermiculite and vermicompost (1:1:1:1), while the lowest net income (₹ 49764 per 1032 m²) was observed in treatment T₇ which consists soil, vermiculite and vermicompost with combination ratio of 1:1:1 and concluded the higher benefit cost ratio of 1:2.04 indicates that strawberry cultivation in growing media is economically viable in the state.

CHAPTER-3

MATERIALS AND METHODS

The present study entitled “Effect of container size and growing media on growth, yield and quality of strawberry (*Fragaria × ananassa* Duch.)” was conducted at the Division of Fruit Science, SKUAST-Jammu (J&K) during 2020-21. The details of materials used, methodologies adopted and experimental techniques employed for the present study are described under the following headings:

3.1 Geographical location of the experimental site

The experimental site was located at an elevation of 300 m above mean sea level and lies at 32° 43" North latitude and 74° 54" East longitude.

3.2 Climate of the experimental site

The experimental area falls under the sub-tropical agroclimatic zone of UT Jammu and Kashmir where October is the first month of the post monsoon autumn. The maximum temperature rises up to 45°C during summer and the minimum temperature falls to 1°C during winter. The mean annual rainfall is about 1000-1200 mm.

3.3 Media and its characteristics

A. Cocopeat

Cocopeat is a growing media made of coconut husk. It is a very good alternative to traditional peat moss and rock wool and having air filled porosity and high water holding capacity makes it, an ideal growing media for the plant crops. It is an eco-friendly, free from soil-borne pathogens and weeds and considered as better organic substrate in soilless cultivation. It has a pH of 5.7 – 6.5 and EC level $<1 \text{ ds m}^{-1}$ is ideal for plant growth.

B. Perlite

Perlite is an amorphous volcanic glass that has a high water holding capacity, formed by hydration of obsidian, and expands up to 7-16 times the original volume.

Bulk density – expanded	–	0.03 – 0.15 g/cm ³
Bulk density – unexpanded	–	1.1 g/cm ³
pH	–	7.38
Electrical conductivity	–	0.02 (ds m ⁻¹)

C. Vermicompost

It is the compost made by microbial activity of earthworms and rich in major and minor plant nutrients and increases the microbial population of nitrogen fixing bacteria, actinomycetes, and symbiotic association of mycorrhiza on the plant root system. It also improves soil phosphorous and nitrogen availability.

3.4 Details of the experiment

3.4.1 Treatment details

3.4.1.1 Growing media

In this experiment, three types of growing media including cocopeat, perlite, and vermicompost were used to produce the different combinations of treatments in different ratios for strawberry cultivation while the sand, soil and FYM were used as control as shown in Table 1.

3.4.1.2 Container

In this experiment, six types of containers with different dimensions were used. The details of which are shown in Table 2.

3.4.1.3 Experimental details

The treatment details of experiment is given below:

- | | | | |
|----|-----------------------|---|---------------|
| 1. | Year of experiment | : | 2020-21 |
| 2. | Experimental site | : | SKUAST, JAMMU |
| 3. | Growing media | : | 7 |
| 4. | Type of container (s) | : | 6 |
| 5. | Number of replication | : | 3 |

Table 1: Details of different growing media used in the experiment

S.No.	Media code	Media used	Ratio
1.	T ₁	Cocopeat+Perlite+Vermicompost	(1:1:1)
2.	T ₂	Cocopeat+Perlite+Vermicompost	(2:1:1)
3.	T ₃	Cocopeat+Perlite+Vermicompost	(3:1:1)
4.	T ₄	Cocopeat+Perlite+Vermicompost	(4:0:1)
5.	T ₅	Cocopeat+Perlite+Vermicompost	(4:1:0)
6.	T ₆	Cocopeat+Perlite+Vermicompost	(4:1:1)
7.	T ₇	Sand + Soil + FYM (control)	(1:1:1)



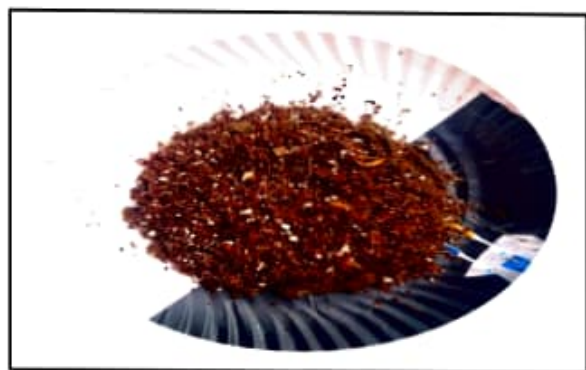
Plate 1: General view of experimental site



Plate 2: Strawberry plantlet

Table 2: Details of different sizes and types container used in the experiment

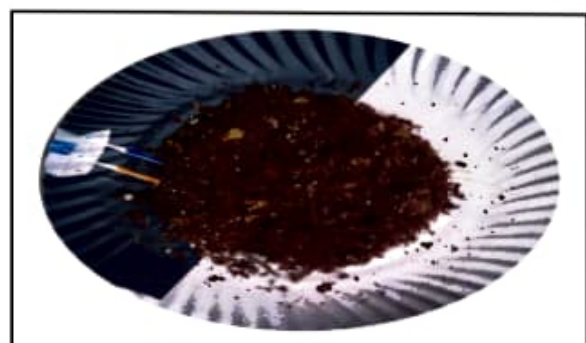
Types of containers	Dimensions (LxBxH)
C ₁ : Polyethylene Bag	(24 cm × 24 cm × 14 cm)
C ₂ : PVC Pot	(25 cm × 21 cm × 12 cm)
C ₃ : Plastic Basket	(20 cm × 20 cm × 10 cm)
C ₄ : Root Trainer Tray	(37 cm × 23 cm × 9 cm)
C ₅ : Plastic Tray	(35 cm × 18 cm × 14 cm)
C ₆ : Earthen Pot	(23 cm × 23 cm × 10 cm)



T₁:
Cocopeat+Perlite+Vermicompost
(1:1:1)



T₂:
Cocopeat+Perlite+Vermicompost
(2:1:1)



T₃:
Cocopeat+Perlite+Vermicompost
(3:1:1)



T₄:
Cocopeat+Perlite+Vermicompost
(4:0:1)



T₅:
Cocopeat+Perlite+Vermicompost
(4:1:0)



T₆:
Cocopeat+Perlite+Vermicompost
(4:1:1)



T₇: Soil+Sand+FYM (1:1:1) (Control)

Plate 3: Different media ratio and combinations prepared for the experiment

1. Number of plants per replication : 2
2. Total number of treatment combination : $6 \times 7 = 42$
3. Total number of plants : $42 \times 2 \times 3 = 252$
4. Experimental Design : Randomized Block Design
(Factorial)

3.4.1.4 Container – Media combinations

C ₁ T ₁	C ₁ T ₂	C ₁ T ₃	C ₁ T ₄	C ₁ T ₅	C ₁ T ₆	C ₁ T ₇
C ₂ T ₁	C ₂ T ₂	C ₂ T ₃	C ₂ T ₄	C ₂ T ₅	C ₂ T ₆	C ₂ T ₇
C ₃ T ₁	C ₃ T ₂	C ₃ T ₃	C ₃ T ₄	C ₃ T ₅	C ₃ T ₆	C ₃ T ₇
C ₄ T ₁	C ₄ T ₂	C ₄ T ₃	C ₄ T ₄	C ₄ T ₅	C ₄ T ₆	C ₄ T ₇
C ₅ T ₁	C ₅ T ₂	C ₅ T ₃	C ₅ T ₄	C ₅ T ₅	C ₅ T ₆	C ₅ T ₇
C ₆ T ₁	C ₆ T ₂	C ₆ T ₃	C ₆ T ₄	C ₆ T ₅	C ₆ T ₆	C ₆ T ₇

3.5 Cultural operations

The details of various cultural operations carried out during the course of experiment are as mentioned below.

3.5.1 Planting material and planting

The uniform runners were selected for planting. The planting was done on 16th October during the year 2020-21.

3.5.2 Preparation of growing media

Three different growing media cocopeat, perlite and vermicompost were used to make the different treatments in different combination ratios for strawberry soilless cultivation. Cocopeat, perlite, vermicompost, and FYM were purchased from the local supplier. Six treatments made out of different combinations of cocopeat, perlite and vermicompost while control comprising of sand, soil and FYM. The media were prepared on the basis of ratios and properly mixed according to the treatments, which are shown in below pictures.

3.5.3 Filling of containers

Before filling the containers, drainage hole were made at the bottom so that excess water can drain out. Each container was filled with prepared growing media of different ratios and planted a single uniform runner in each container.

3.6 Observation recorded

3.6.1 Growth parameters

3.6.1.1 Plant height (cm)

The plant height was measured individually from the base of the plant to the tip of the main stem with a measuring scale and result was expressed as average height in centimetres and subjected to statistical analysis.

3.6.1.2 Plant spread (cm)

The plant spread was calculated by considering the plant canopy in East-West (EW) and North-South (NS) direction with the help of measuring scale and the average of both was expressed as plant spread in centimeters and subjected to statistical analysis.

3.6.1.3 Survival percentage (%)

The survival percentage of the potted plants was calculated by dividing the total number of plants survived after planting by the total number of plants planted, multiplied by 100. The survival percentage was calculated by the formula given below-

$$\text{Survival (\%)} = \frac{\text{Number of plants survived}}{\text{Total number of plants planted}} \times 100$$

3.6.2 Shoot parameters

3.6.2.1 Shoot length (cm)

The plants were randomly selected and the length of their shoot under each treatment was measured with the help of a measuring scale from the point of its emergence to the tip of the fully opened leaf and results were expressed as average shoot length in centimeter (cm).

3.6.2.2 Crown diameter (mm)

The crown diameter of plant was calculated by using Vernier Calipers scale and it is expressed in millimeters.

3.6.2.3 Number of runners per plant

A total number of runners per plant were counted at the end of the growing season and the average number of runners per plant was calculated.

3.6.2.4 Runners length (cm)

The plants were randomly selected and the length of their runners under each treatment was measured with the help of a measuring scale from the axil of leaf to the end of apex and results were expressed as average runner length in centimetre (cm).

3.6.2.5 Fresh weight of shoots (g)

The shoots were detached from the plant and the fresh weight of shoot was recorded separately in electronic weighing balance and the average was calculated in grams.

3.6.2.6 Dry weight of shoots (g)

The uprooted plants were oven dried at a temperature of 65 °C until a constant weight was obtained. After complete drying, the dry weight of shoots was calculated with the help of an electronic weighing balance.

3.6.3 Leaf parameters

3.6.3.1 Number of leaves per plant

The number of fully opened leaves per plant was counted from the time of planting to the end of growing season (October-March) and the average number of leaves per plant was calculated at each observation.

3.6.3.2 Leaf area (cm²)

Five leaves from each plant were taken and their area was measured by using leaf area meter (Licor Model – 3100) and the average area of five leaves was multiplied by total the number of leaves to obtain the total leaf area of a single plant and expressed as cm².

3.6.3.3 Petiole length (cm)

The length of the petiole was measured by selecting five random leaves per plant with the help of a measuring scale and the average petiole length was expressed as centimeter.

3.6.3.4 Fresh weight of leaves (g)

The leaves were detached from the plant and the fresh weight of leaves was recorded separately in electronic weighing balance and the average was calculated in grams.

3.6.3.5 Dry weight of leaves (g)

The sample taken for calculating the dry weight of leaves was subjected to a temperature of 65 °C in an oven for drying till the leaves reached a constant weight and weighed in grams by using an electronic weighing balance and the mean was taken for analysis.

3.6.3.6 Leaf chlorophyll content

Chlorophyll content in leaves of strawberry was determined by the use of chlorophyll meter SPAD-502 manufactured by KONICA MINALTA SENSING, INC. in Japan. The data were expressed as percent.

3.6.4 Flower parameters

3.6.4.1 Days taken first flower to produce.

The days taken to first flower to produce was recorded from the date of planting to the date of appearance of the first flower and the average value was worked out and expressed in number of days.

3.6.4.2 Duration of flowering

Duration of flowering was recorded from first flower initiation till last flower emergence was counted and the average value was worked out and expressed in the number of days.

3.6.4.3 Number of flowers per plant

It was determined by counting the number of flowers till it reached the final harvest and the average number of flowers per plant was worked out.

3.6.5 Root parameters

3.6.5.1 Fresh weight of root (g)

The uprooted roots were detached from the plant and washed with tap water. The separated root was immediately weighted in grams using weighing balance and the mean was taken for analysis.

3.6.5.2 Dry weight of root (g)

The uprooted roots were detached from the plant and placed in butter paper bags and dried in a hot air oven at 65 °C till the roots reached a constant weight. The separated root was immediately weighted in grams by using weighing balance and the mean was taken for analysis.

3.6.5.3 Average length of primary roots (cm)

The average length of randomly selected primary roots developed per replication was calculated with the help of uprooting plants and measured length by using measuring scale and their average was expressed as primary root length in centimeter.

3.6.5.4 Average length of secondary roots (cm)

The average length of randomly selected secondary roots developed per replication was calculated with the help of uprooting plants and measured length by using a measuring scale and their average was expressed as secondary root length in centimeters.

3.6.6 Fruit parameters

3.6.6.1 Number of berries per plant

The total numbers of berries were counted in each treatment at the time of harvesting (last week of January to the first week of April) and their average was expressed in the number of berries per plant.

3.6.6.2 Berry weight (g)

The berry weight of each treatment from each plant was calculated by weighing the individual berry on an electronic balance and the average weight (g) per berry was worked out.

3.6.6.3 Berry breadth (cm)

The breadth of randomly selected berries per replication was measured by using a digital vernier caliper at the maximum breadth and average breadth was calculated in centimeter.

3.6.6.4 Berry length (cm)

The length of randomly selected berries per replication were measured from length from the stalk and the floral end of the fruit was measured by a using digital vernier caliper and the mean value was calculated in centimeter.

3.6.6.5 Total yield per plant (g)

Once the berries turns fully colored were picked along with about one quarter of the stem attached. The harvesting operation was done in the early morning hours to reduce the transpiration losses. The observations on berry weight were recorded from each treatment after harvest. The total yield per plant was calculated by dividing the recorded yield by the number of surviving plants and expressed as gram per plant.

3.6.7 Biochemical parameters

3.6.7.1 pH

For each replicate, strawberries were squeezed, about 25 ml of juice was taken in a beaker and the pH values were determined by using the digital pH meter (Elico, India) with a standard buffer solution of pH 4.0 as described in A.O.A.C. (1995).

3.6.7.2 Total soluble solids (°Brix)

The juice was extracted from the strawberry fruit with a help of hand extractor and strained through a muslin cloth. The strained juice of each sample was thoroughly stirred before

recording. Hand Refractometer having a range of 0 to 30 °Brix (ERMA made) by putting a drop of juice or pulp on the screen and taking the readings. The Refractometer was calibrated with distilled water with every use and the values were expressed in degree brix soluble solids.

3.6.7.3 Titratable Acidity (%)

The titratable acidity was estimated in terms of citric acid by titration process against NaOH solution as per A.O.A.C. (1996). The total titratable acidity was expressed in terms of citric acid percent on a fresh fruit weight basis.

3.6.7.4 TSS: Acid ratio

The TSS: Acid ratio was calculated by dividing the value of total soluble solids (TSS) by the acidity percentage of the corresponding treatment.

3.6.7.5 Total sugars (%)

Twenty five grams of fruit pulp was thoroughly homogenized with distilled water. To this, 2 ml of saturated lead acetate solution was added and the precipitate was filtered into flask containing 5 ml of potassium oxalate solution. The filtrate was shaken and refiltered. 100 ml of this dealed and clarified solution was hydrolyzed by adding 5 ml concentrated HCl and was kept overnight. The excess of HCl was neutralized with concentrated sodium hydroxide solution. Total sugars were estimated by titrating a boiling mixture of 5 ml each of Fehling A and Fehling B solution against a hydrolyzed aliquot, using methylene blue as an indicator. The endpoint was marked by the emergence of a brick red color. Total volume of aliquot used was recorded and total sugars were calculated by the procedure described in A.O.A.C. (1995).

3.6.7.6 Reducing sugars (%)

Boiling mixture containing five ml each of Fehling A and Fehling B reagents was titrated against unhydrolyzed but dealed and clarified aliquot by using methylene blue as an indicator. The endpoint was spotted by the emergence of a brick red color. Total volume of aliquot used was noted and the reducing sugars were calculated by the procedure described in A.O.A.C. (1995).

3.6.7.7 Non-reducing sugars (%)

The amount of non-reducing sugars was obtained by subtracting the amount of reducing sugars from total sugars and multiplying the difference by standard factor 0.95 and expressed in percentage.

$$\text{Non-reducing sugars} = (\text{Total sugars} - \text{Reducing sugars}) \times 0.95$$

3.6.7.8 Ascorbic acid (mg per 100 g of fruit)

The ascorbic acid was estimated by using the procedure given in A.O.A.C. (1990).

Reagents

Metaphosphoric acid solution (3%)

Metaphosphoric acid (HPO ₃)	:	15 g
Glacial acetic acid	:	40 ml
Volume	:	500 ml
2, 6-Dichlorophenol Indophenol dye		
2, 6-Dichlorophenol Indophenol dye	:	50 mg
Sodium bicarbonate	:	42 mg
Volume	:	200 ml

Preparation of standard ascorbic acid solution

50 mg of ascorbic acid was dissolved in metaphosphoric acid solution (3%) and the final volume was made to 50 ml by adding metaphosphoric acid. One ml of standard ascorbic acid solution was used to standardize the dye with the appearance of pink color as the endpoint.

Estimation:

Ascorbic acid was extracted from the fruit by macerating 5 g of sample with 3 percent metaphosphoric acid and final volume was made to 50 ml and a pinch of activated charcoal was added for the disappearance of red color. It was then filtered through rough filter paper and 2 ml aliquot was taken in conical flask from the filtrate and titrated against 2, 6 Dichlorophenol Indophenol dye. The endpoint was the appearance of pink color persisting up to one minute. The

ascorbic acid content was calculated using the following formula and results were expressed in mg of ascorbic acid per 100 g of sample.

$$\text{Ascorbic acid (mg/ 100 g)} = \frac{\text{Titrate value (Y)} \times \text{Total volume made up}}{\text{Standard reading} \times \text{Vol. of aliquot} \times \text{Vol. of sample}} \times 100$$

where, Y is ml of 2, 6- Dichlorophenol Indophenol dye used.

3.6.8 Economic analysis

3.6.8.1 Cost of cultivation

The cost of all inputs viz., planting material, cocopeat, perlite, vermicompost, FYM, containers, and the labour cost was considered to work out the cost of cultivation.

3.6.8.2 Gross Income

The gross income was calculated on the basis of the prevailing market cost of strawberry fruits.

$$\text{Gross income (GI)} = \text{Fruit yield} \times \text{Price of produce}$$

3.6.8.3 Net income

The net income per treatment was calculated by using the formula:

$$\text{Net income} = \text{Gross income} - \text{Cost of treatment.}$$

3.6.8.4 Benefit-cost ratio

The benefit-cost ratio for different treatments was worked out on the basis of the price of inputs used for strawberry cultivation and price of marketable produce in the local market by using the formula given by Reddy and Ram (1996):

$$\text{Benefit cost ratio} = \frac{\text{Gross income}}{\text{Cost of cultivation}}$$

The data pertaining to different characteristics of present investigation entitled “**Effect of container size and growing media on growth, quality, and yield of strawberry (*Fragaria × ananassa* Duch.)**” were statistically analyzed and the experimental results so obtained are presented under the following headings:

4.1 Growth Parameters

4.1.1 Plant height (cm)

The data in Table 3 revealed that the plant height showed significant influence by different container sizes and growing media. It was found that treatment T₃ (Cocopeat + Perlite + Vermicompost, 3:1:1) resulted in maximum plant height (22.09 cm) followed by T₂ (20.60 cm) treatment comprising of cocopeat, perlite and vermicompost with combination ratio of 2:1:1 and the minimum plant height (14.76 cm) was noted in T₇ (control). Amongst the different containers used, the plants grown in PVC pots (C₂) had tallest plants (20.96 cm) which was followed by plastic tray (C₅) (20.29 cm) and shortest plant height (18.30 cm) was observed in polyethylene bag (C₁). It is evident from the data that the interaction between growing media and container size resulted in significant effect on plant height. It was reported that the maximum plant height (23.24 cm) was obtained in C₂T₃ followed by C₅T₃ (23.11 cm) whereas, the minimum plant height was found in C₄T₇ (13.14 cm).

4.1.2 Plant spread (cm)

The data on plant spread in Table 4 recorded varied significantly in response to the use of different container size and growing media. The maximum plant spread (32.23 cm) was produced by treatment T₃ (Cocopeat + Perlite + Vermicompost, 3:1:1) followed by T₂ (30.79 cm) treatment comprising of cocopeat, perlite alongwith vermicompost with combination ratio of 2:1:1, whereas minimum (24.12 cm) was observed in T₇ (control). In case of different containers, maximum plant spread (31.21cm) was reported in PVC pots (C₂) followed by plastic tray (C₅) (30.36 cm), whereas, minimum plant spread (27.78 cm)

was found in root trainer tray (C₄). Also significant results were obtained as an outcome of the interaction of growing media and containers size. The maximum plant spread (33.45 cm) was produced by C₂T₃ which was followed by C₅T₃ (33.02 cm) whereas, the minimum plant spread was noted in C₄T₇ (21.94 cm).

4.1.3 Survival percentage

It is evident from Table 5 that all soilless media improved survival percent of plants compared to the control. The maximum survival percentage (88.89%) was recorded in T₃ (cocopeat + perlite + vermicompost, 3:1:1), which was found to be at par with T₂ and T₆ (86.11%) whereas, the minimal survival per cent (66.67%) in T₇ (control). In case of different containers used, the plants grown in PVC pots (C₂) had highest survival percentage (88.10%), which was at par with plastic tray (C₅) (87.71%) and shortest survival percentage (69.05 %) was observed in earthen pots (C₆). The interaction between substrate and container size resulted in non significant effect on survival rate and was found that maximum survival percentage (100 %) was observed in C₂T₃, at par with (100 %) in C₅T₃ whereas, the minimum length of runner was observed in C₄T₇ (50.00%)

4.2 Shoot Parameters

4.2.1 Shoot length (cm)

The data pertaining to the shoot length is tabulated in Table 6. It is apparent from the data that the container size and growing media yielded a significant effect on the shoot length in strawberry. The container C₂ (PVC pots) produced maximum shoot length (16.40 cm), which was followed by plastic tray (C₅) (16.22 cm), while the minimum shoot length (15.42 cm) was observed in polyethylene bag (C₁). It was recorded from the data that the treatment T₃ (Cocopeat + Perlite + Vermicompost, 3:1:1) produced maximum shoot length (17.50 cm) which was followed by T₂ (17.16 cm) treatment comprising of cocopeat, perlite alongwith vermicompost with combination ratio of 3:1:1 whereas, minimum shoot length (11.93 cm) was observed in T₇ (control). Further, the interaction between the growing media and container size were found significant and

revealed that the longest shoot length (18.08 cm) was observed in C₂T₃, which was followed by C₅T₃ (17.97 cm) and shortest shoot length (11.09 cm) was observed in C₄T₇.

4.2.2 Crown diameter (mm)

The results depicted in Table 7 showed that the use of container size and growing media brings out significant effect on crown diameter in strawberry. The recorded results makes it evident as maximum crown diameter (18.56 mm) was found in PVC pots (C₂), succeeded by plastic tray (C₅) (18.12 mm). On the contrary minimum crown diameter (16.91 mm) was found in root trainer tray (C₄). The results obtained in T₃ (19.64 mm) treatment consisting of cocopeat, perlite alongwith vermicompost with ratio of 3:1:1 was found to be maximum, followed by T₂ (18.69 mm) treatment consisting of cocopeat, perlite alongwith vermicompost with combination ratio of 2:1:1. On the contrary minimum (14.58 mm) was observed in T₇ (control). The interaction effect of growing media and container size emanated significant results. The maximum crown diameter (20.63 mm) was found in C₂T₃ followed by C₅T₃ (20.21 mm). On the contrary minimum (13.53 mm) was observed in C₄T₇.

4.2.3 Number of runners per plant

The perusal of data presented in Table 8 revealed that the number of runners per plant recorded varied significantly in response to the use of different container size and growing media. The maximum number of runners per plant (34.72) was produced by growing media T₃ (Cocopeat + Perlite + Vermicompost, 3:1:1) followed by treatment T₂ (32.83) comprising of cocopeat, perlite and vermicompost with proportion of 2:1:1, whereas minimum (19.97) was observed in control (T₇). Among the containers used, the maximum number of runners per plant (34.83) was produced by PVC pots (C₂) followed by plastic tray C₅ (31.95), whereas, minimum number of runners per plant (22.76) was observed in root trainer tray (C₄). Also significant results were obtained as an outcome of the interaction of growing media and containers size. The maximum number of runners per plant (41.50) was produced by C₂T₃ which was followed by C₅T₃ (39.00) whereas, the minimum number of runners per plant (16.00) was noted in C₄T₇.

4.2.4 Runners length (cm)

The data mentioned in Table 9 showed that the effect of container size and growing media on length of runner came to be significant. It was reported that growing media T₃ comprising of cocopeat, perlite alongwith vermicompost with combination ratio of 3:1:1 resulted in maximum runner's length (55.27 cm) followed by T₂ (53.05 cm) (Cocopeat + Perlite + Vermicompost, 2:1:1) and the lowest runners length (43.96 cm) was observed in T₇ (control). In case of different containers used, the plants grown in PVC pots (C₂) had longest runners length (53.42 cm) followed by plastic tray (C₅) (50.72 cm) and shortest length of runners (40.73 cm) was observed in earthen pots (C₆). The interaction between substrate and container size resulted in significant effect on runner length and was found that maximum runner length (57.51 cm) was observed in C₂T₃ followed by (56.10 cm) in C₅T₃ whereas, the minimum length of runner was observed in C₄T₇ (41.63 cm).

4.2.5 Fresh weight of shoots

From the perusal data given in Table 10 revealed that the container size and growing media showed a significant effect on the fresh weight of shoot in strawberry and reported that the PVC container (C₂) produced maximum fresh weight of shoot (6.65 g), followed by plastic tray (C₅) (6.50 g). On the other hand minimum fresh weight of shoot (5.83 g) was observed in root trainer tray (C₄). The data also depicted that T₃ treatment consisting of cocopeat, perlite and vermicompost with combination ratio of 3:1:1 reported maximum fresh weight of shoot (6.98 g), followed by T₂ (6.69 g) treatment consisting of cocopeat, perlite alongwith vermicompost with combination ratio of 2:1:1 whereas minimum fresh weight of shoot (4.77 g) was observed in T₇ (control). Additionally significant results were revealed from the combined effect of growing media and container size. The maximum fresh weight of shoot (7.25 g) was observed in C₂T₃ followed by C₅T₃ (7.14 g) whereas minimum fresh weight of shoot (4.11 g) was noted in C₄T₇.

4.2.6 Dry weight of shoots (g)

The results presented in Table 11 depicted that the maximum shoot dry weight (1.20 g) was found in PVC pots (C₂), succeeded by plastic tray (C₅) (1.11 g). On the

contrary minimum shoot dry weight (0.90 g) was found in root trainer tray (C₄). As it is evident from the table that the treatment T₃ comprising of cocopeat, perlite and vermicompost with proportion of 3:1:1 was found to be maximum shoot dry weight (1.50 g), which was followed by treatment T₂ (1.18 g) (Cocopeat + Perlite + Vermicompost, 2:1:1) while the minimum was observed in T₇ (0.71 g) (control). Also, the interaction effect of growing media and container size emanated significant results and reported that the maximum shoot dry weight (1.66 g) was found in C₂T₃, followed by in C₅T₃ (1.58 g). On the contrary minimum shoot dry weight (0.60g) was observed in C₄T₇.

4.3 Leaf Parameters

4.3.1 Number of leaves per plant

The data on number of leaves per plant recorded in Table 12 varied significantly in response to the use of different container size and growing media. The highest number of leaves per plant (19.52) was produced by growing media T₃ followed by T₂ (17.97), whereas minimum (10.86) was observed in T₇ (control). In case of different containers, maximum number of leaves per plant (19.59) was reported in PVC pots (C₂) followed by plastic tray (C₅) (18.16), whereas, minimum number of leaves per plant (10.76) was found in root trainer tray (C₄). Also significant results were obtained as an outcome of the interaction of growing media and containers size and concluded that the maximum number of leaves per plant (24.33) was produced by C₂T₃, followed by C₅T₃ (22.16) whereas, the minimum number of leaves per plant (6.33) was noted in C₄T₇.

4.3.2 Leaf area (cm²)

It is noticeable from the data in Table 13 that the variation with respect to leaf area among different container size and growing media was found to be significant during the present studies. The data revealed that T₃ treatment comprising of cocopeat, perlite and vermicompost with combination ratio of 3:1:1 recorded the maximum leaf area (132.29 cm²), followed by T₆ (130.17 cm²) treatment which comprises different growing media i.e cocopeat, perlite and vermicompost with combination ratio of 4:1:1 and it was significantly superior to all other treatments. The minimum leaf area (117.53 cm²) was observed under T₇ (control) which was significantly different from all other

treatments. On the other hand, the plants grown in PVC pots (C_2) had maximum leaf area (131.19 cm^2) followed by root trainer tray (C_5) (129.60 cm^2) and minimum leaf area (119.05 cm^2) was observed in root trainer tray (C_4). The interaction between substrate and container size resulted in significant effect on leaf area and was found that maximum leaf area (137.11 cm^2) was observed in C_2T_3 followed by (135.74 cm^2) in C_5T_3 whereas, the minimum length of runner (110.86 cm^2) was observed in C_4T_7 .

4.3.3 Petiole length (cm)

The data related to the effect of different container size and growing media on petiole length are presented in Table 14. The maximum petiole length (9.53 cm) was recorded under T_3 treatment consisting of cocopeat, perlite and vermicompost with combination ratio of 3:1:1, which was followed by T_2 treatment comprising of different growing media i.e cocopeat, perlite and vermicompost with ratio of 2:1:1 with petiole length (8.98 cm) and the minimum petiole length (5.41 cm) was observed in T_7 (control). Amongst the different containers used, the plants grown in PVC pots (C_2) had tallest petiole length (8.94 cm) followed by earthen pots (C_6) (8.21 cm) and shortest petiole length (7.14 cm) was observed in root trainer tray (C_4). It is evident from the data that the interaction between growing media and container size resulted in significant effect on petiole length. It was reported that the maximum petiole length (10.46 cm) was obtained in C_2T_3 followed by C_6T_3 (9.80 cm) whereas, the minimum petiole length (7.14 cm) was found in C_4T_7 .

4.3.4 Fresh weight of leaves (g)

From the data showed in Table 15, it is evident that the differences among the container sizes and growing media were found to be significant in respect of fresh weight of leaves. The maximum fresh weight of leaves 2.53 g was observed in T_3 treatment (Cocopeat + Perlite + Vermicompost, 3:1:1) followed by T_2 (2.37g) (Cocopeat + Perlite + Vermicompost, 2:1:1). However, minimum fresh weight of leaves (1.37 g) was recorded under T_7 (control). In case of different containers used, the plants grown in PVC pots (C_2) had maximum fresh weight of leaves (2.37 g) followed by plastic tray (C_5) (2.24 g) and minimum fresh weight of leaves (1.88 g) was observed in root trainer tray (C_4). The

interaction between substrate and container size resulted in significant effect on fresh weight of leaves and was found that maximum fresh weight of leaves (2.77 g) was observed in C₂T₃ followed by (2.70 g) in C₅T₃ whereas, the minimum fresh weight of leaves was reported in C₄T₇ (1.07 g).

4.3.5 Dry weight of leaves (g)

The data pertaining to the dry weight of leaves is tabulated in Table 16. It is apparent from the data that the container size and growing media yielded a significant impact on the dry weight of leaves in strawberry. The PVC container (C₂) produced maximum dry weight of leaves (1.22 g), which was followed by plastic tray (C₅) (1.15 g), while the minimum dry weight of leaves (0.92g) was observed in polyethylene bag (C₁). It was apparent from the data that the treatment T₃ (Cocopeat + Perlite + Vermicompost, 3:1:1) produced maximum dry weight of leaves (1.31 g), followed by T₂ (1.17 g) (Cocopeat + Perlite + Vermicompost, 2:1:1) whereas, minimum dry weight of leaves (0.80 g) was observed in T₇ (control). Further, the interaction between the growing media and container size were found significant and revealed that the maximum dry weight of leaves (1.58 g) was observed in C₂T₃, which was followed by C₅T₃ (1.49 g) and minimum dry weight of leaves (0.66 g) was observed in C₄T₇.

4.3.6 Leaf chlorophyll content (%)

The data in Table 17 revealed that the leaf chlorophyll content came to be significant in response to the use of different container size and growing media. It was found that growing media T₃ (Cocopeat + Perlite + Vermicompost, 3:1:1) resulted in maximum leaf chlorophyll content (41.12 %) followed by T₂ (39.39 %) (Cocopeat + Perlite + Vermicompost, 2:1:1) and the minimum leaf chlorophyll content (32.74 %) was observed in T₇ (control). Amongst the different containers used, the plants grown in PVC pots (C₂) had maximum leaf chlorophyll content (39.87 %) followed by earthen pots (C₆) (39.28 %) and minimum leaf chlorophyll content (35.07 %) was observed in root trainer tray (C₄). It is evident from the data that the interaction between growing media and container size resulted in significant effect on leaf chlorophyll content. It was reported that the maximum leaf chlorophyll content (43.28 %) was obtained in C₂T₃ followed by

C₆T₃ (42.18 %) whereas, the minimum leaf chlorophyll content was found in C₄T₇ (30.96 %).

4.4 Flower Parameters

4.4.1 Days taken first flower to produce

It is clear from the data given in Table 18, differences among the container size and growing media were found to be significant in respect of days taken to initiate first flower. However, T₃ (Cocopeat + Perlite + Vermicompost, 3:1:1) took minimum days (78.72) for first flower to open, which was followed by T₂ (87.00) (Cocopeat + Perlite + Vermicompost, 2:1:1) and maximum days (110.36) required for first flower to open was observed under T₇ (control). In containers, the minimum days taken to first flower (84.36) was produced by earthen pots (C₆) followed by PVC pot (C₂) (89.38), whereas, maximum days taken to initiate first flower (110.55) was observed in root trainer tray (C₄). Also significant results were obtained as an outcome of the interaction of growing media and containers size. The minimum days taken to initiate first flower (70.66) was produced by C₆T₃ which was followed by C₂T₃ (72.83) whereas, the maximum days taken to initiate first flower was noted in C₄T₇ (121.66).

4.4.2 Duration of flowering

The data in Table 19 clearly indicate the significant influence of different container size and growing media on duration of flowering. The maximum duration of flowering (62.19 days) was observed under T₃ (Cocopeat + Perlite + Vermicompost, 3:1:1), which was followed by T₆ (60.08 days) (Cocopeat + Perlite + Vermicompost, 4:1:1) whereas, minimum duration of flowering (48.75 days) was observed under T₇ (control). Amongst the different containers used, the maximum duration of flowering (62.81 days) was observed under PVC pot (C₂), which was followed by earthen pot (C₆) (59.76 days). However, minimum duration of flowering (49.12 days) was observed under root trainer tray (C₄). Also, the interaction effect of growing media and container size emanated significant results and reported that the maximum duration of flowering (67.66 days) was found in C₂T₃ which was followed by in C₆T₃ (65.50 days). On the contrary minimum duration of flowering (41.50 days) was observed in C₄T₇.

4.4.3 Number of flowers per plant

The data pertaining to the number of flowers per plant is tabulated in Table 20. It is evident from the data that the container size and growing media showed a significant impact on the number of flowers per plant in strawberry. The earthen pot (C₆) produced maximum number of flowers per plant (29.47), which was followed by PVC pot (C₂) (26.71), while the minimum number of flowers per plant (16.42) was observed in root trainer tray (C₄). It was apparent from the data that the treatment T₃ (Cocopeat + Perlite + Vermicompost, 3:1:1) produced maximum number of flowers per plant (29.08), followed by T₂ (26.63) (Cocopeat + Perlite + Vermicompost, 2:1:1) whereas, minimum number of flowers per plant (15.88) was observed in T₇ control. Further, the interaction between the growing media and container size were found significant and revealed that the highest number of flowers per plant (35.66) was observed in C₆T₃, which was followed by C₂T₃ (33.00) and lowest number of flowers per plant (10.50) was observed in C₄T₇.

4.5 Root Parameters

4.5.1 Fresh weight of root (g)

From the perusal data given in Table 21 revealed that the container size and growing media showed a significant effect on the fresh weight of shoot in strawberry and reported that the PVC container (C₂) produced maximum root fresh weight (8.42 g), which was followed by plastic tray (C₅) (8.07 g). On the other hand, minimum root fresh weight (7.22 g) was observed in root trainer tray (C₄). The data also depicted that the treatment T₃ (Cocopeat + Perlite + Vermicompost, 3:1:1) reported maximum root fresh weight (8.83 g), followed by T₂ (8.34 g) (Cocopeat + Perlite + Vermicompost, 2:1:1) whereas minimum root fresh weight (6.85 g) was observed in T₇ (control). Additionally significant results were revealed from the combined effect of growing media and container size. The maximum root fresh weight (9.29 g) was observed in C₂T₃ followed by C₅T₃ (8.97 g) whereas minimum root fresh weight (6.26 g) was reported in C₄T₇.

4.5.2 Dry weight of root (g)

The data pertaining to the effect of different container size and growing media on dry weight of root are presented in Table 22. The maximum dry weight of root of 5.73 g

was observed under T₃ treatment (Cocopeat + Perlite + Vermicompost, 3:1:1), which was followed by T₂ treatment (Cocopeat + Perlite + Vermicompost, 2:1:1) with dry weight of root of 5.10 g and the minimum dry weight of root of 3.09 g was observed in T₇ (control). Amongst the different containers used, the plants grown in earthen pot (C₆) had maximum dry weight of root (4.76 g) followed by PVC pot (C₂) (4.68 g) and minimum dry weight of root (3.18 g) was observed in root trainer tray (C₄). It is evident from the data that the interaction between growing media and container size resulted in significant effect on dry weight of root. It was reported that the maximum dry weight of root (6.63 g) was obtained in C₅T₃ followed by C₂T₃ (6.20 g) whereas, the minimum dry weight of root was found in C₄T₇ (2.20 g).

4.5.3 Average length of primary roots (cm)

The recorded data in Table 23 reveals that, the effect of container size and growing media on average length of primary roots came to be significant. It was reported that growing treatment T₃ (Cocopeat + Perlite + Vermicompost, 3:1:1) resulted in maximum length of primary roots (18.93 cm) followed by T₂ (17.72 cm) (Cocopeat + Perlite + Vermicompost, 2:1:1) and the minimum length of primary roots (13.44 cm) was observed in T₇ (control). In case of different containers used, the plants grown in PVC pot (C₂) had longest length of primary roots (17.45 cm) followed by plastic tray (C₅) (17.18 cm) and shortest length of primary roots length (15.81 cm) was observed in root trainer tray (C₄). The interaction between substrate and container size resulted in significant effect on length of primary roots and was found that maximum length of primary roots (19.48 cm) was observed in C₂T₃ followed by (19.18 cm) in C₅T₃ whereas, the minimum length of primary roots length was observed in C₄T₇ (12.98 cm).

4.5.2 Average length of secondary roots (cm)

The data pertaining to the length of secondary roots is tabulated in Table 24. It is showed that the container size and growing media yielded a significant impact on the length of secondary roots in strawberry. The PVC container (C₂) produced maximum length of secondary roots (4.00 cm), which was followed by plastic tray (C₅) (3.88 cm), while the minimum length of secondary roots (3.33 cm) was observed in root trainer tray

(C₄). It was apparent from the data that the treatment T₃ (Cocopeat + Perlite + Vermicompost, 3:1:1) produced maximum length of secondary roots (4.42 cm), followed by T₂ (4.14 cm) (Cocopeat + Perlite + Vermicompost, 2:1:1) whereas, minimum length of secondary roots (2.98 cm) was observed in T₇ (control). Further, the interaction between the growing media and container size were found significant and revealed that the longest length of secondary roots (4.71 cm) was observed in C₂T₃, followed by C₅T₃ (4.60 cm) and shortest length of secondary roots (2.66 cm) was observed in C₄T₇.

4.6 Fruit parameter

4.6.1 Number of berries per plant

The perusal of data presented in Table 25 revealed that the number of berries per plant recorded varied significantly in response to the use of different container size and growing media. The maximum number of berries per plant (27.30) was produced by treatment T₃ (Cocopeat + Perlite + Vermicompost, 3:1:1) followed by T₂ (24.50) (Cocopeat + Perlite + Vermicompost, 2:1:1), whereas minimum (13.16) was observed in T₇ (control). Among the containers used, the maximum number of berries per plant (27.21) was produced by PVC pot (C₂) followed by plastic tray (C₅) (23.59), whereas, minimum number of berries per plant (14.07) was observed in root trainer tray (C₄). Also significant results were obtained as an outcome of the interaction of growing media and containers size. The maximum number of berries per plant (33.00) was produced by C₆T₃, followed by C₂T₃ (31.00) whereas, the minimum number of berries per plant was noted in C₄T₇ (7.00).

4.6.2 Berry weight (g)

From the data presented in Table 26, it is evident that the differences among the container size and growing media were found to be significant in respect of berry weight. The maximum berry weight 17.25 g was observed in T₁ (Cocopeat + Perlite + Vermicompost, 1:1:1) treatment followed by T₂ (15.99 g) (Cocopeat + Perlite + Vermicompost, 2:1:1). However, minimum berry weight (11.13 g) was recorded under T₇ (control). In case of different containers used, the plants grown in PVC pot (C₂) had maximum berry weight (15.98 g) followed by earthen pot (C₆) (15.30 g) and minimum

berry weight (11.41 g) was observed in root trainer tray (C₄). The interaction between substrate and container size resulted in significant effect on berry weight and was found that maximum berry weight (20.25g) was observed in C₂T₁ followed by (18.61 g) in C₆T₁ whereas, the minimum berry weight was reported in C₄T₇ (9.97 g).

4.6.3 Berry breadth (cm)

It is evident from the data presented in Table 27 that the variation with respect to berry breadth among different container size and growing media was significant during the present studies. The data showed that T₁ (Cocopeat + Perlite + Vermicompost, 1:1:1) recorded the maximum berry breadth (3.72 cm), followed by T₂ (3.61 cm) (Cocopeat + Perlite + Vermicompost, 2:1:1) and it was significantly superior to all other treatments. The minimum berry breadth (2.81 cm) was observed under T₇ (control) which was significantly different from all other treatments. On the other hand, the plants grown in PVC pot (C₂) had maximum berry breadth (3.69 cm) followed by earthen pot (C₆) (3.54 cm) and minimum berry breadth (2.74 cm) was observed in root trainer tray (C₄). The interaction between substrate and container size resulted in significant effect on berry breadth and was found that maximum berry breadth (4.27 cm) was observed in C₂T₁ followed by (4.04 cm) in C₆T₁ whereas, the minimum berry breadth was observed in C₄T₇ (2.29 cm).

4.6.4 Berry length (cm)

A perusal of data presented in Table 28 reveals that the container size and growing media had a significant effect on berry length in strawberry. It is evident from the data that the maximum berry length (4.54 cm) was recorded in T₃ (Cocopeat + Perlite + Vermicompost, 3:1:1), which was however found to be statistically at par with T₂ (4.28 cm) (Cocopeat + Perlite + Vermicompost, 2:1:1). The minimum berry length (3.36 cm) was observed in T₇ (control). While studying the response to containers, it was observed that earthen pot (C₆) resulted in maximum berry length (4.53 cm) and it was significantly superior to all other treatments, though it was followed by PVC pot (C₂) (4.21 cm) and the minimum berry length (3.63 cm) was recorded in root trainer tray (C₄). Further, the interaction between the growing media and container size were found significant and

revealed that the maximum berry length (4.91 cm) was observed in C₆T₃, followed by C₂T₃ (4.81 cm) and minimum berry length (3.03 cm) was observed in C₄T₇.

4.6.5 Total yield per plant (g)

From the data presented in Table 29, it is evident that the differences among the various growing media were found to be significant in respect of yield per plant. The maximum yield per plant of 365.69 g per plant was observed under T₃ (Cocopeat + Perlite + Vermicompost, 3:1:1) followed by T₂ (348.92 g) (Cocopeat + Perlite + Vermicompost, 2:1:1). However, minimum berry yield per plant (178.24 g) was recorded under T₇ (control). The earthen pot (C₆) produced maximum yield per plant (397.54 g), followed by PVC pot (C₂) (374.55 g), while the minimum yield per plant (184.08 g) was observed in root trainer tray (C₄). Further, the interaction between the growing media and container size were found significant and revealed that the highest yield per plant (464.30 g) was observed in C₆T₃, followed by C₂T₃ (459.41 g) and lowest yield per plant (132.58 g) was observed in C₄T₇.

4.7 Biochemical Parameters

4.7.1 pH

The results depicted in Table 30 showed that the use of container size and growing media brings out significant effect on pH in strawberry. The recorded results makes it evident as maximum pH (3.16) was found in PVC pot (C₂), succeeded by plastic tray (C₅) (3.01). On the contrary minimum pH (2.56) was found in root trainer tray (C₄). The results obtained in media T₃ (3.13) (Cocopeat + Perlite + Vermicompost, 3:1:1) was found to be maximum pH, followed by T₂ (3.31) (Cocopeat + Perlite + Vermicompost, 2:1:1). On the contrary minimum pH (2.44) was observed in T₇ (control). The interaction effect of growing media and container size emanated significant results. The maximum pH (3.48) was found in C₂T₃ followed by C₅T₃ (3.32). On the contrary minimum (2.13) was observed in C₄T₇.

4.7.2 Total soluble solids (°Brix)

The perusal of data presented in Table 31 revealed that the TSS in strawberry recorded varied significantly in response to the use of different container size and

growing media. The maximum TSS (8.98 °Brix) was produced by growing media T₅ (Cocopeat + Perlite + Vermicompost, 4:1:0) followed by T₃ (Cocopeat + Perlite + Vermicompost, 3:1:1) (8.66 °Brix), whereas minimum (7.57 °Brix) was observed in T₇ (control). Among the containers used, the maximum TSS (9.62 °Brix) was produced by earthen pot (C₆) followed by polyethylene bag (C₁) (8.97 °Brix), whereas, minimum TSS (6.88 °Brix) was observed in root trainer tray (C₄). Also significant results were obtained as an outcome of the interaction of growing media and containers size. The maximum TSS (10.16°Brix) was produced by C₆T₅ followed by C₁T₅ (9.97 °Brix) whereas, the minimum TSS was noted in C₄T₇ (6.03 °Brix).

4.7.3 TSS: Acid ratio

The data pertaining to the TSS: Acid ratio is tabulated in Table 32. It is evident from the data that the container size and growing media yielded a significant effect on the TSS: Acid ratio in strawberry. The earthen pot (C₆) produced maximum TSS: Acid ratio (13.37), followed by PVC pot (C₂) (13.26), while the minimum TSS: Acid ratio (12.61) was observed in root trainer tray (C₄). It was apparent from the data that the treatment T₁ (Cocopeat + Perlite + Vermicompost, 1:1:1) produced maximum TSS: Acid ratio (13.68), followed by T₃ (13.33) (Cocopeat + Perlite + Vermicompost, 3:1:1) whereas, minimum TSS: Acid ratio (12.51) was observed in T₇ (control). Further, the interaction between the growing media and container size were found significant and revealed that the maximum TSS: Acid ratio (14.01) was observed in C₆T₁, which was at par with C₂T₁ (13.93) and minimum TSS: Acid ratio (11.97) was observed in C₄T₇.

4.7.4 Total sugars (%)

From the data presented in Table 33, it is apparent that the differences among the various growing media were found to be significant in respect of total sugar. The maximum total sugars 6.77% was observed in T₃ treatment (Cocopeat + Perlite + Vermicompost, 3:1:1) followed by T₆ (6.66 %) (Cocopeat + Perlite + Vermicompost, 4:1:1). However, minimum total sugars (5.58 %) was recorded under T₇ (control). In case of different containers used, the plants grown in PVC pot (C₂) had maximum total sugars (7.04 %) followed by plastic tray (C₅) (6.78 %) and minimum total sugars (5.29 %) was

observed in root trainer tray (C₄). The interaction between substrate and container size resulted in significant effect on berry weight and was found that maximum total sugars (7.53 %) was observed in C₂T₃ followed by (7.24 %) in C₅T₃ whereas, the minimum total sugars was reported in C₄T₇ (4.95 %).

4.7.5 Reducing sugars (%)

The data in Table 34 revealed that the reducing sugars came to be significant in response to the use of different container size and growing media. It was found that growing media T₃ (Cocopeat + Perlite + Vermicompost, 3:1:1) resulted in maximum reducing sugars (5.54 %) followed by T₂ (5.14 %) (Cocopeat + Perlite + Vermicompost, 2:1:1) and the minimum reducing sugars (4.57 %) was observed in T₇ (control). Amongst the different containers used, the plants grown in earthen pot (C₆) had highest reducing sugars (5.37 %) followed by PVC pot (C₂) (5.23 %) and lowest reducing sugars (4.62 %) was observed in root trainer tray (C₄). It is evident from the data that the interaction between growing media and container size resulted in significant effect on reducing sugar. It was reported that the maximum reducing sugars (5.86 %) was obtained in C₆T₃ followed by C₂T₃ (5.72 %) whereas, the minimum reducing sugars was found in C₄T₇ (4.10 %).

4.7.6 Non-reducing sugars (%)

The results depicted in Table 35 showed that the use of container size and growing media brings out significant effect on non-reducing sugars in strawberry. The recorded results makes it evident as maximum non-reducing sugars (2.45 %) was found in PVC pot (C₂), succeeded by plastic tray (C₅) (2.27 %). On the contrary minimum non-reducing sugars (1.77 %) was found in root trainer tray (C₄). The results obtained in treatment T₃ (3.23 %) (Cocopeat + Perlite + Vermicompost, 3:1:1) was found to be maximum non-reducing sugars, followed by T₂ (2.76 %) (Cocopeat + Perlite + Vermicompost, 2:1:1). On the contrary minimum (1.28 %) was observed in T₇ (control). The interaction effect of growing media and container size emanated significant results. The maximum non-reducing sugars (3.63 %) was found in C₂T₃ followed by C₅T₃ (3.36 %). On the contrary minimum non-reducing sugars (1.10 %) was observed in C₄T₇.

4.7.7 Ascorbic acid (mg per 100 g of fruit)

The data pertaining to an ascorbic acid is tabulated in Table 36. It is evident from the data that the growing media and container size yielded significant effect on an ascorbic acid in strawberry. The PVC pot (C₂) produced maximum ascorbic acid (46.97 mg per 100 g of fruit), followed by plastic tray (C₅) (39.52 mg per 100g of fruit), while the minimum ascorbic acid (34.17 mg per 100 g of fruit) was observed in root trainer tray (C₄). It was apparent from the data that the media T₃ (Cocopeat + Perlite + Vermicompost, 3:1:1) produced maximum ascorbic acid (49.33 mg per 100 g of fruit), followed by T₂ (46.28 mg per 100 g of fruit) (Cocopeat + Perlite + Vermicompost, 2:1:1) whereas, minimum ascorbic acid (29.21 mg per 100 g of fruit) was observed in T₇ (control). Further, the interaction between the growing media and container size were found significant and revealed that the maximum ascorbic acid (54.68 mg per 100 g of fruit) was observed in C₂T₃, followed by C₅T₃ (51.05 mg per 100 g of fruit) and minimum ascorbic acid (23.97 mg per 100 g of fruit) was observed in C₄T₇.

4.8 Economic analysis

The benefit cost ratio in strawberry grown in polyethylene bags with different media combination which is presented in Table 37. The table reveals that highest cost ₹ 280.32 incurred in strawberry plant planted in T₁ (Cocopeat + Perlite + Vermicompost, 1:1:1) which was followed by T₆ (₹ 275.56) (Cocopeat + Perlite + Vermicompost, 4:1:1) and minimum (₹ 88.56) was in T₇ (control). The cost of polyethylene bags, plants, and labour was found to be same in all the combinations. The table further revealed that maximum average yield per treatment was observed in T₃ (1.7 kg), followed by T₂ (1.6 kg) and minimum was in T₇ (0.88 kg). Gross income on the basis of average yield per plant and survival percentage was found to be maximum (₹ 425.00) in T₃, followed by T₂ (₹ 400.00) and minimum (₹ 220.00) was observed in control (T₇). The net returns were found to be maximum in case of T₃ (₹ 169.16) with B:C ratio of 1:1.66, followed by T₂ (₹165.94) with B:C ratio of 1:1.70 and minimum was noted in T₅ (₹ 25.16) with B:C ratio of 1:1.10.

Cost and return analysis of strawberry plants planted in PVC pots with different media combination which is presented in Table 38 and observed that highest cost (₹ 495.00) incurred in strawberry plant planted in T₄ which was followed by T₅ (₹491.76) and minimum was in T₇ (₹344.22). The cost of PVC pots, plants, and labour was found to be same in all the treatments. The table further reported that maximum average yield per treatment was observed in T₃ (2.75 kg), followed by T₂ (2.65 kg) and minimum was in T₇ (1.08 kg). Gross income on the basis of average yield per plant and survival percentage was found to be maximum (687.50) in T₃, followed by T₂ (₹662.50) and minimum (₹270.00) was observed in control (T₇). The net returns were noted to be maximum in case of T₃ (₹248.06) with B:C ratio of 1:1.56, followed by T₂ (₹227.44) with B:C ratio of 1:1.52 and minimum was noted in T₅ (₹74.22) with B:C ratio of 1:0.78.

The data on the cost and return analysis of strawberry plants planted in plastic baskets with different media combination is presented in Table 39. The data revealed that highest cost recorded in strawberry plant planted in T₅ (₹346.32) which was followed by T₃ (₹320.30) and minimum (₹177.39) was in T₇. The cost of plastic baskets, plants, and labour was noted to be same in all the treatments. The data further showed that maximum average yield per treatment was observed in T₃ (2.13 kg), followed by T₂ (2.04 kg) and minimum was in T₇ (1.01 kg). The data on gross income on the basis of survival percentage was found to be maximum (₹532.50) in T₃, followed by T₂ (₹510.00) and minimum (₹252.50) was observed in control (T₇). The data on net return with benefit: cost ratio revealed that maximum was found in of T₃ (₹212.20) with B:C ratio of 1:1.66, followed by T₂ (₹194.16) with B:C ratio of 1:1.62 and minimum was noted in T₅ (3.68) with B:C ratio of 1:1.01.

The benefit cost ratio in strawberry grown in root trainer tray with different media combination which is presented in Table 40. The table reveals that highest cost (₹621.24) was incurred in strawberry plant planted in T₅ which was followed by T₆ (₹612.60) and minimum was in T₇ (₹500.76). The cost of root trainer trays, planting material, and labour was found to be same in all the combinations. The table further revealed that maximum average yield per treatment was observed in T₃ (1.42 kg), followed by T₂ (1.27 kg) and minimum was in T₇ (0.80 kg). Gross income on the basis of average yield per plant and

survival percentage was found to be maximum (₹355.00) in T₃, followed by T₂ (₹317.50) and minimum (₹200.00) was observed in control (T₇). The net returns were found to be negative in all treatments.

Cost and return analysis of strawberry plants planted in plastic tray with different media combination which is presented in Table 41 and observed that highest cost incurred in strawberry plant planted in T₅ (₹594.12) which was followed by T₃ (₹567.42) and minimum was in T₇ (₹323.46). The cost of plastic trays, planting material, and labour was found to be same in all the treatment combination. The table further reported that maximum average yield per treatment was observed in T₃ (2.40 kg), followed by T₂ (2.30 kg) and minimum was in T₇ (1.03 kg). Gross income on the basis of average yield per plant and survival percentage was found to be maximum (₹600.00) in T₃, followed by T₂ (₹575.00) and minimum (₹275.50) was observed in control (T₇). The net returns were noted to be maximum in case of T₇ (₹65.96) with B:C ratio of 1:0.80, followed by T₂ (₹45.99) with B:C ratio of 1:1.09 and minimum was noted in T₅ which gave negative returns.

The data on the cost and return analysis of strawberry plants planted in earthen pots with different media combination is presented in Table 42. The data revealed that highest cost recorded in strawberry plant planted in T₅ (₹452.76) which was at par with T₆ (₹452.22) and minimum was in T₇ (₹279.21). The cost of earthen pots, plants, and labour was noted to be same in all the treatments. The data further showed that maximum average yield per treatment was observed in T₃ (2.81 kg), significantly at par with T₂ (2.80 kg) and minimum was in T₇ (1.62 kg). The data on gross income on the basis of survival percentage was found to be maximum (₹702.50) in T₃, at par with T₂ (₹700.00) and minimum (₹405.00) was observed in control (T₇). The data on net return with benefit: cost ratio revealed that maximum was found in of T₂ (₹277.36) with B:C ratio of 1:1.66, followed by T₁ (₹272.08) with B:C ratio of 1:1.68 and minimum was noted in T₇ (₹125.79) with B:C ratio of 1:1.45.

Table 3: Effect of container size and growing media on plant height (cm) in strawberry cv. Chandler

Media	Containers						Mean
	C ₁	C ₂	C ₃	C ₄	C ₅	C ₆	
T ₁ (1:1:1)	17.81	20.31	18.23	17.22	19.44	18.65	18.61
T ₂ (2:1:1)	20.01	22.15	20.11	19.37	21.62	20.34	20.60
T ₃ (3:1:1)	21.34	23.24	22.03	20.36	23.11	22.47	22.09
T ₄ (4:0:1)	18.27	21.16	19.05	18.08	20.60	19.56	19.45
T ₅ (4:1:0)	18.03	20.83	18.61	17.74	20.06	19.11	19.06
T ₆ (4:1:1)	19.13	21.52	19.40	18.57	21.11	20.02	19.96
T ₇ (1:1:1)	13.50	17.54	14.01	13.14	16.12	14.23	14.76
Mean	18.30	20.96	18.78	17.78	20.29	19.20	
SE ± m			T - 0.006	C - 0.006	T x C - 0.01		
C.D(P = 0.05)			T - 0.01	C - 0.02	T x C - 0.05		

C₁- Polyethylene Bags

C₄ - Root Trainer Tray

T₁ to T₆ – Cocopeat : Perlite : Vermicompost

C₂ - PVC Pots

C₅ - Plastic Tray

T₇ – Sand : Soil : FYM (1:1:1)

C₃ -Plastic Basket

C₆ - Earthen Pots

Table 4: Effect of container size and growing media on plant spread (cm) in strawberry cv. Chandler

Media	Containers						Mean
	C ₁	C ₂	C ₃	C ₄	C ₅	C ₆	
T ₁ (1:1:1)	27.89	30.50	28.52	27.31	29.74	28.86	28.80
T ₂ (2:1:1)	30.03	32.25	30.21	29.57	31.96	30.75	30.79
T ₃ (3:1:1)	31.64	33.45	32.09	30.56	33.02	32.66	32.23
T ₄ (4:0:1)	28.57	31.58	29.14	28.20	30.80	29.97	29.71
T ₅ (4:1:0)	28.09	30.97	28.91	27.94	30.10	29.31	29.22
T ₆ (4:1:1)	29.31	32.11	29.80	28.97	31.41	30.09	30.28
T ₇ (1:1:1)	22.31	27.66	23.12	21.94	25.52	23.97	24.12
Mean	28.29	31.21	28.83	27.78	30.36	29.37	
SE ± m			T - 0.003	C - 0.003	T x C – 0.008		
C.D_(P = 0.05)			T - 0.01	C - 0.01	T x C – 0.02		

C₁- Polyethylene Bags

C₄ - Root Trainer Tray

T₁ to T₆ – Cocopeat : Perlite : Vermicompost

C₂ - PVC Pots

C₅ - Plastic Tray

T₇ – Sand : Soil : FYM (1:1:1)

C₃ -Plastic Basket

C₆ - Earthen Pots

Table 5: Effect of container size and growing media on survival percentage in strawberry cv. Chandler

Media	Containers						Mean
	C ₁	C ₂	C ₃	C ₄	C ₅	C ₆	
T ₁ (1:1:1)	66.67	83.33	66.67	50.00	83.33	83.33	72.22
T ₂ (2:1:1)	83.33	83.33	83.33	83.33	100.00	83.33	86.11
T ₃ (3:1:1)	83.33	100.00	83.33	83.33	100.00	83.33	88.89
T ₄ (4:0:1)	83.33	100.00	83.33	66.67	83.33	66.67	77.78
T ₅ (4:1:0)	66.67	66.67	66.67	66.67	83.33	83.33	72.22
T ₆ (4:1:1)	83.33	100.00	83.33	83.33	83.33	83.33	86.11
T ₇ (1:1:1)	66.67	83.33	50.00	50.00	66.67	66.67	66.67
Mean	73.81	88.10	76.19	69.05	85.71	78.57	
SE ± m			T - N.S	C - N.S	T x C - N.S		
C.D_(P = 0.05)			T - N.S	C - N.S	T x C - N.S		

C₁- Polyethylene Bags

C₄ - Root Trainer Tray

T₁ to T₆ – Cocopeat : Perlite : Vermicompost

C₂ - PVC Pots

C₅ - Plastic Tray

T₇ – Sand : Soil : FYM (1:1:1)

C₃ -Plastic Basket

C₆ - Earthen Pots

Table 6: Effect of container size and growing media on shoot length (cm) in strawberry cv. Chandler

Media	Containers						Mean
	C ₁	C ₂	C ₃	C ₄	C ₅	C ₆	
T ₁ (1:1:1)	15.62	16.05	15.75	15.31	16.00	15.83	15.76
T ₂ (2:1:1)	17.06	17.54	17.15	16.61	17.35	17.25	17.16
T ₃ (3:1:1)	17.20	18.08	17.33	16.86	17.97	17.57	17.50
T ₄ (4:0:1)	16.21	16.78	16.32	16.08	16.57	16.45	16.40
T ₅ (4:1:0)	15.67	16.36	15.98	15.52	16.26	16.14	15.99
T ₆ (4:1:1)	16.74	17.15	16.85	16.51	17.09	16.98	16.89
T ₇ (1:1:1)	11.43	12.84	11.85	11.09	12.32	12.10	11.93
Mean	15.70	16.40	15.89	15.42	16.22	16.05	
SE ± m			T - 0.005 C- 0.004	T x C – 0.01			
C.D_(P = 0.05)			T - 0.01 C- 0.01	T x C – 0.03			

C₁- Polyethylene Bags

C₄ - Root Trainer Tray

T₁ to T₆ – Cocopeat : Perlite : Vermicompost

C₂ - PVC Pots

C₅ - Plastic Tray

T₇ – Sand : Soil : FYM (1:1:1)

C₃ -Plastic Basket

C₆ - Earthen Pots

Table 7: Effect of container size and growing media on crown diameter (mm) in strawberry cv. Chandler

Media	Containers						Mean
	C ₁	C ₂	C ₃	C ₄	C ₅	C ₆	
T₁ (1:1:1)	16.77	17.92	16.99	16.48	17.42	17.10	17.11
T₂ (2:1:1)	18.19	19.65	18.39	18.04	19.14	18.73	18.69
T₃ (3:1:1)	19.09	20.63	19.31	18.86	20.21	19.77	19.64
T₄ (4:0:1)	17.53	18.77	17.87	17.10	18.30	18.09	17.94
T₅ (4:1:0)	17.19	18.12	17.41	16.85	17.79	17.51	17.48
T₆ (4:1:1)	17.92	19.12	18.11	17.51	18.87	18.53	18.34
T₇ (1:1:1)	13.90	15.70	14.31	13.53	15.10	14.97	14.58
Mean	17.23	18.56	17.48	16.91	18.12	17.81	
SE ± m			T - 0.01	C - 0.01	T x C – 0.04		
C.D(P = 0.05)			T - 0.04	C - 0.04	T x C – 0.11		

C₁- Polyethylene Bags

C₄ - Root Trainer Tray

T₁ to T₆ – Cocopeat : Perlite : Vermicompost

C₂ - PVC Pots

C₅ - Plastic Tray

T₇ – Sand : Soil : FYM (1:1:1)

C₃ -Plastic Basket

C₆ - Earthen Pots

Table 8: Effect of container size and growing media on number of runners per plant in strawberry cv. Chandler

Media	Containers						Mean
	C ₁	C ₂	C ₃	C ₄	C ₅	C ₆	
T ₁ (1:1:1)	20.50	30.50	23.00	18.83	28.66	23.83	24.22
T ₂ (2:1:1)	29.00	40.00	31.00	27.00	36.50	33.50	32.83
T ₃ (3:1:1)	30.83	41.50	32.50	29.50	39.00	35.00	34.72
T ₄ (4:0:1)	24.00	36.16	27.00	23.00	32.50	27.83	28.41
T ₅ (4:1:0)	21.83	33.66	24.83	20.50	30.66	26.00	26.25
T ₆ (4:1:1)	26.50	38.00	28.83	24.50	34.00	31.00	30.47
T ₇ (1:1:1)	18.16	24.00	18.83	16.00	22.33	20.50	19.97
Mean	24.40	34.83	26.57	22.76	31.95	28.23	
SE ± m							T - 0.11 C- 0.10 T x C – 0.28
C.D_(P = 0.05)							T - 0.32 C- 0.30 T x C – 0.80

C₁- Polyethylene Bags

C₄ - Root Trainer Tray

T₁ to T₆ – Cocopeat : Perlite : Vermicompost

C₂ - PVC Pots

C₅ - Plastic Tray

T₇ – Sand : Soil : FYM (1:1:1)

C₃ -Plastic Basket

C₆ - Earthen Pots

Table 9: Effect of container size and growing media on runner length (cm) in strawberry cv. Chandler

Media	Containers						Mean
	C ₁	C ₂	C ₃	C ₄	C ₅	C ₆	
T ₁ (1:1:1)	46.84	51.96	47.02	46.51	48.38	47.11	47.97
T ₂ (2:1:1)	52.02	55.88	52.44	51.84	53.23	52.84	53.05
T ₃ (3:1:1)	54.17	57.51	54.75	53.69	56.10	55.40	55.27
T ₄ (4:0:1)	49.11	53.46	49.52	48.98	50.74	49.88	50.29
T ₅ (4:1:0)	47.07	52.12	47.33	46.83	49.99	47.92	48.55
T ₆ (4:1:1)	49.92	54.35	50.03	49.51	51.72	51.03	51.09
T ₇ (1:1:1)	42.13	48.63	42.58	41.63	44.87	43.89	43.96
Mean	48.75	53.42	49.10	48.43	50.72	40.73	
SE ± m			T - 0.02	C - 0.02	T x C – 0.05		
C.D_(P = 0.05)			T - 0.06	C - 0.05	T x C – 0.14		

C₁- Polyethylene Bags

C₄ - Root Trainer Tray

T₁ to T₆ – Cocopeat : Perlite : Vermicompost

C₂ - PVC Pots

C₅ - Plastic Tray

T₇ – Sand : Soil : FYM (1:1:1)

C₃ -Plastic Basket

C₆ - Earthen Pots

Table 10: Effect of container size and growing media on fresh weight of shoot (g) in strawberry cv. Chandler

Media	Containers						Mean
	C ₁	C ₂	C ₃	C ₄	C ₅	C ₆	
T ₁ (1:1:1)	5.73	6.53	5.85	5.59	6.33	6.08	6.02
T ₂ (2:1:1)	6.48	7.03	6.58	6.37	6.94	6.73	6.69
T ₃ (3:1:1)	6.84	7.25	6.93	6.70	7.14	7.03	6.98
T ₄ (4:0:1)	6.15	6.81	6.18	6.04	6.67	6.35	6.37
T ₅ (4:1:0)	6.03	6.65	6.06	5.86	6.49	6.17	6.21
T ₆ (4:1:1)	6.29	6.95	6.43	6.14	6.78	6.52	6.52
T ₇ (1:1:1)	4.32	5.32	4.71	4.11	5.19	4.96	4.77
Mean	5.98	6.65	6.10	5.83	6.50	6.26	
SE ± m	T - 0.005 C- 0.004 T x C – 0.01						
C.D(P = 0.05)	T - 0.01 C- 0.01 T x C – 0.03						

C₁- Polyethylene Bags

C₄ - Root Trainer Tray

T₁ to T₆ – Cocopeat : Perlite : Vermicompost

C₂ - PVC Pots

C₅ - Plastic Tray

T₇ – Sand : Soil : FYM (1:1:1)

C₃ -Plastic Basket

C₆ - Earthen Pots

Table 11: Effect of container size and growing media on dry weight of shoot (g) in strawberry cv. Chandler

Media	Containers						Mean
	C ₁	C ₂	C ₃	C ₄	C ₅	C ₆	
T ₁ (1:1:1)	0.80	1.02	0.83	0.74	0.91	0.87	0.86
T ₂ (2:1:1)	1.08	1.41	1.14	1.00	1.26	1.19	1.18
T ₃ (3:1:1)	1.43	1.66	1.48	1.37	1.58	1.51	1.50
T ₄ (4:0:1)	0.95	1.15	1.00	0.86	1.13	1.05	1.02
T ₅ (4:1:0)	0.89	1.08	0.97	0.78	0.99	0.92	0.94
T ₆ (4:1:1)	1.02	1.22	1.06	0.94	1.17	1.12	1.09
T ₇ (1:1:1)	0.63	0.85	0.68	0.60	0.77	0.72	0.71
Mean	0.97	1.20	1.02	0.90	1.11	1.05	
SE ± m			T - 0.003	C- 0.003	T x C – 0.01		
C.D_(P = 0.05)			T - 0.01	C- 0.01	T x C – 0.02		

C₁- Polyethylene Bags

C₄ - Root Trainer Tray

T₁ to T₆ – Cocopeat : Perlite : Vermicompost

C₂ - PVC Pots

C₅ - Plastic Tray

T₇ – Sand : Soil : FYM (1:1:1)

C₃ -Plastic Basket

C₆ - Earthen Pots

Table 12: Effect of container size and growing media on number of leaves per plant in strawberry cv. Chandler

Media	Containers						Mean
	C ₁	C ₂	C ₃	C ₄	C ₅	C ₆	
T ₁ (1:1:1)	10.33	17.00	12.66	8.00	15.83	14.00	12.97
T ₂ (2:1:1)	14.33	23.00	17.00	13.83	20.50	19.16	17.97
T ₃ (3:1:1)	16.50	24.33	18.00	15.83	22.16	20.33	19.52
T ₄ (4:0:1)	12.33	19.33	15.33	10.33	18.50	16.83	15.44
T ₅ (4:1:0)	11.16	18.16	13.83	9.33	17.00	15.33	14.13
T ₆ (4:1:1)	13.16	20.83	15.83	11.66	20.16	18.16	16.63
T ₇ (1:1:1)	8.50	14.50	10.50	6.33	13.00	12.33	10.86
Mean	12.33	19.59	14.73	10.76	18.16	16.59	
SE ± m			T - 0.09	C - 0.08	T x C – 0.22		
C.D_(P = 0.05)			T - 0.24	C - 0.26	T x C – 0.64		

C₁- Polyethylene Bags

C₄ - Root Trainer Tray

T₁ to T₆ – Cocopeat : Perlite : Vermicompost

C₂ - PVC Pots

C₅ - Plastic Tray

T₇ – Sand : Soil : FYM (1:1:1)

C₃ -Plastic Basket

C₆ - Earthen Pots

Table 13: Effect of container size and growing media on leaf area (cm²) in strawberry cv. Chandler

Media	Containers						Mean
	C ₁	C ₂	C ₃	C ₄	C ₅	C ₆	
T₁ (1:1:1)	119.82	129.23	123.04	114.90	127.04	125.73	123.30
T₂ (2:1:1)	121.96	130.07	124.35	116.97	128.80	127.95	125.02
T₃ (3:1:1)	128.74	137.11	132.03	126.24	135.74	133.83	132.29
T₄ (4:0:1)	125.19	135.53	128.07	121.34	132.14	130.80	128.85
T₅ (4:1:0)	123.12	131.15	126.70	119.31	130.29	129.20	126.67
T₆ (4:1:1)	127.22	134.61	130.06	123.74	133.76	131.95	130.17
T₇ (1:1:1)	116.91	120.76	118.31	110.86	119.41	118.92	117.53
Mean	123.28	131.19	126.08	119.05	129.60	128.34	
SE ± m			T - 0.09 C- 0.08	T x C – 0.22			
C.D_(P = 0.05)			T - 0.25 C- 0.23	T x C – 0.62			

C₁- Polyethylene Bags

C₄ - Root Trainer Tray

T₁ to T₆ – Cocopeat : Perlite : Vermicompost

C₂ - PVC Pots

C₅ - Plastic Tray

T₇ – Sand : Soil : FYM (1:1:1)

C₃ -Plastic Basket

C₆ - Earthen Pots

Table 14: Effect of container size and growing media on petiole length (cm) in strawberry cv. Chandler

Media	Containers						Mean
	C ₁	C ₂	C ₃	C ₄	C ₅	C ₆	
T ₁ (1:1:1)	6.72	8.22	7.07	6.49	7.50	7.89	7.31
T ₂ (2:1:1)	8.92	10.05	8.49	8.50	8.75	9.17	8.98
T ₃ (3:1:1)	9.14	10.46	9.26	9.04	9.48	9.80	9.53
T ₄ (4:0:1)	7.22	9.09	7.85	7.10	8.08	8.36	7.95
T ₅ (4:1:0)	7.03	8.64	7.38	6.85	7.74	8.12	7.63
T ₆ (4:1:1)	7.63	9.58	8.10	7.32	8.23	8.95	8.30
T ₇ (1:1:1)	4.92	6.54	5.09	4.72	5.96	5.20	5.41
Mean	7.37	8.94	7.61	7.14	7.96	8.21	
SE ± m	T - 0.01 C- 0.01 T x C – 0.02						
C.D(P = 0.05)	T - 0.03 C- 0.03 T x C – 0.08						

C₁- Polyethylene Bags

C₄ - Root Trainer Tray

T₁ to T₆ – Cocopeat : Perlite : Vermicompost

C₂ - PVC Pots

C₅ - Plastic Tray

T₇ – Sand : Soil : FYM (1:1:1)

C₃ -Plastic Basket

C₆ - Earthen Pots

Table 15: Effect of container size and growing media on fresh weight of leaves per plant (g) in strawberry cv. Chandler

Media	Containers						Mean
	C ₁	C ₂	C ₃	C ₄	C ₅	C ₆	
T ₁ (1:1:1)	1.88	2.21	1.97	1.81	2.27	2.03	2.00
T ₂ (2:1:1)	2.25	2.59	2.31	2.17	2.48	2.42	2.37
T ₃ (3:1:1)	2.37	2.77	2.47	2.23	2.70	2.62	2.53
T ₄ (4:0:1)	2.05	2.40	2.09	1.96	2.28	2.20	2.16
T ₅ (4:1:0)	1.99	2.33	2.02	1.89	2.19	2.13	2.09
T ₆ (4:1:1)	2.11	2.47	2.17	2.06	2.36	2.28	2.24
T ₇ (1:1:1)	1.14	1.87	1.26	1.07	1.55	1.35	1.37
Mean	1.97	2.37	2.04	1.88	2.24	2.14	
SE ± m			T - 0.004	C - 0.003	T x C – 0.01		
C.D_(P = 0.05)			T - 0.01	C - 0.01	T x C – 0.03		

C₁- Polyethylene Bags

C₄ - Root Trainer Tray

T₁ to T₆ – Cocopeat : Perlite : Vermicompost

C₂ - PVC Pots

C₅ - Plastic Tray

T₇ – Sand : Soil : FYM (1:1:1)

C₃ -Plastic Basket

C₆ - Earthen Pots

Table 16: Effect of container size and growing media on dry weight of leaves (g) in strawberry cv. Chandler

Media	Containers						Mean
	C ₁	C ₂	C ₃	C ₄	C ₅	C ₆	
T ₁ (1:1:1)	0.77	1.02	0.82	0.71	0.98	0.86	0.86
T ₂ (2:1:1)	1.05	1.42	1.09	0.95	1.31	1.20	1.17
T ₃ (3:1:1)	1.16	1.58	1.22	1.09	1.49	1.34	1.31
T ₄ (4:0:1)	0.92	1.19	0.95	0.82	1.14	0.97	1.00
T ₅ (4:1:0)	0.86	1.10	0.89	0.77	1.04	0.91	0.93
T ₆ (4:1:1)	0.97	1.28	1.02	0.90	1.21	1.10	1.08
T ₇ (1:1:1)	0.72	0.96	0.77	0.66	0.92	0.80	0.80
Mean	0.92	1.22	0.96	0.84	1.15	1.02	
SE ± m	T - 0.002 C- 0.002 T x C – 0.006						
C.D_(P = 0.05)	T - 0.01 C- 0.01 T x C – 0.02						

C₁- Polyethylene Bags

C₄ - Root Trainer Tray

T₁ to T₆ – Cocopeat : Perlite : Vermicompost

C₂ - PVC Pots

C₅ - Plastic Tray

T₇ – Sand : Soil : FYM (1:1:1)

C₃ -Plastic Basket

C₆ - Earthen Pots

Table 17: Effect of container size and growing media on leaf chlorophyll content (%) in strawberry cv. Chandler

Media	Containers						Mean
	C ₁	C ₂	C ₃	C ₄	C ₅	C ₆	
T ₁ (1:1:1)	33.84	39.34	34.28	33.03	35.32	38.35	35.70
T ₂ (2:1:1)	37.85	41.44	38.96	37.02	40.16	40.89	39.39
T ₃ (3:1:1)	39.85	43.28	40.55	39.37	41.45	42.18	41.12
T ₄ (4:0:1)	35.59	40.13	36.50	34.64	37.52	39.95	37.39
T ₅ (4:1:0)	34.70	39.73	35.82	34.06	36.87	39.17	36.73
T ₆ (4:1:1)	37.05	40.68	37.37	36.38	38.78	40.26	38.42
T ₇ (1:1:1)	31.08	34.47	31.77	30.96	33.96	34.17	32.74
Mean	35.71	39.87	36.47	35.07	37.73	39.28	
SE ± m	T - 0.01 C- 0.01 T x C – 0.04						
C.D_(P = 0.05)	T - 0.05 C- 0.05 T x C – 0.12						

C₁- Polyethylene Bags

C₄ - Root Trainer Tray

T₁ to T₆ – Cocopeat : Perlite : Vermicompost

C₂ - PVC Pots

C₅ - Plastic Tray

T₇ – Sand : Soil : FYM (1:1:1)

C₃ -Plastic Basket

C₆ - Earthen Pots

Table 18: Effect of container size and growing media on days taken to first flower in strawberry cv. Chandler

Media	Containers						Mean
	C ₁	C ₂	C ₃	C ₄	C ₅	C ₆	
T ₁ (1:1:1)	104.83	97.50	116.33	118.00	110.16	90.66	106.25
T ₂ (2:1:1)	86.50	83.00	93.00	97.16	88.33	77.00	87.00
T ₃ (3:1:1)	75.83	72.83	84.33	89.50	79.00	70.66	78.72
T ₄ (4:0:1)	97.50	92.16	104.00	116.66	101.33	85.33	99.50
T ₅ (4:1:0)	101.00	95.33	112.16	119.50	106.50	88.33	103.81
T ₆ (4:1:1)	90.50	87.33	98.16	111.33	94.16	82.33	93.97
T ₇ (1:1:1)	108.16	100.33	118.66	121.66	117.33	96.16	110.36
Mean	94.90	89.38	103.79	110.55	99.55	84.36	
SE ± m	T - 0.16 C- 0.15 T x C – 0.40						
C.D(P = 0.05)	T - 0.46 C- 0.43 T x C – 1.15						

C₁- Polyethylene Bags

C₄ - Root Trainer Tray

T₁ to T₆ – Cocopeat : Perlite : Vermicompost

C₂ - PVC Pots

C₅ - Plastic Tray

T₇ – Sand : Soil : FYM (1:1:1)

C₃ -Plastic Basket

C₆ - Earthen Pots

Table 19: Effect of container size and growing media on duration of flowering in strawberry cv. Chandler

Media	Containers						Mean
	C ₁	C ₂	C ₃	C ₄	C ₅	C ₆	
T ₁ (1:1:1)	48.50	60.00	52.00	44.66	55.00	56.00	52.69
T ₂ (2:1:1)	54.83	65.16	57.50	51.16	59.50	62.50	58.44
T ₃ (3:1:1)	58.50	67.66	61.00	56.50	64.00	65.50	62.19
T ₄ (4:0:1)	52.50	63.50	56.00	49.00	58.16	60.16	56.56
T ₅ (4:1:0)	50.16	62.33	53.83	46.83	56.50	57.83	54.58
T ₆ (4:1:1)	57.00	65.83	58.66	54.16	60.83	64.00	60.08
T ₇ (1:1:1)	45.16	55.16	47.16	41.50	51.16	52.33	48.75
Mean	52.38	62.81	55.17	49.12	57.88	59.76	
SE ± m			T - 0.11	C - 0.10	T x C – 0.28		
C.D(P = 0.05)			T - 0.32	C - 0.30	T x C – 0.80		

C₁- Polyethylene Bags

C₄ - Root Trainer Tray

T₁ to T₆ – Cocopeat : Perlite : Vermicompost

C₂ - PVC Pots

C₅ - Plastic Tray

T₇ – Sand : Soil : FYM (1:1:1)

C₃ -Plastic Basket

C₆ - Earthen Pots

Table 20: Effect of container size and growing media on number of flowers per plant in strawberry cv. Chandler

Media	Containers						Mean
	C ₁	C ₂	C ₃	C ₄	C ₅	C ₆	
T ₁ (1:1:1)	16.00	22.16	17.33	13.00	21.33	26.66	19.41
T ₂ (2:1:1)	21.66	31.66	25.50	20.50	27.50	33.00	26.63
T ₃ (3:1:1)	24.50	33.00	28.33	22.66	30.33	35.66	29.08
T ₄ (4:0:1)	18.33	26.66	21.83	16.33	24.50	29.66	22.88
T ₅ (4:1:0)	16.50	25.33	19.50	14.50	23.00	28.33	21.19
T ₆ (4:1:1)	20.16	30.16	24.00	17.50	26.33	31.50	24.94
T ₇ (1:1:1)	13.66	18.00	15.33	10.50	16.33	21.50	15.88
Mean	18.69	26.71	21.69	16.42	24.19	29.47	
SE ± m	T - 0.16 C - 0.15 T x C - 0.41						
C.D(P = 0.05)	T - 0.47 C - 0.44 T x C - 1.16						

C₁- Polyethylene Bags

C₄ - Root Trainer Tray

T₁ to T₆ – Cocopeat : Perlite : Vermicompost

C₂ - PVC Pots

C₅ - Plastic Tray

T₇ – Sand : Soil : FYM (1:1:1)

C₃ -Plastic Basket

C₆ - Earthen Pots

Table 21: Effect of container size and growing media on fresh weight of roots (g) in strawberry cv. Chandler

Media	Containers						Mean
	C ₁	C ₂	C ₃	C ₄	C ₅	C ₆	
T ₁ (1:1:1)	6.71	8.07	7.12	6.49	7.53	7.26	7.20
T ₂ (2:1:1)	8.12	8.87	8.23	7.86	8.51	8.43	8.34
T ₃ (3:1:1)	8.61	9.29	8.73	8.55	8.97	8.83	8.83
T ₄ (4:0:1)	7.43	8.40	7.64	7.12	8.11	7.98	7.78
T ₅ (4:1:0)	7.26	8.25	7.75	7.04	7.98	7.75	7.61
T ₆ (4:1:1)	7.96	8.65	8.12	7.18	8.29	8.18	8.06
T ₇ (1:1:1)	6.46	7.44	6.83	6.26	7.10	7.01	6.85
Mean	7.50	8.42	7.72	7.22	8.07	7.92	
SE ± m			T - 0.005	C- 0.004	T x C – 0.01		
C.D_(P = 0.05)			T - 0.01	C- 0.01	T x C – 0.03		

C₁- Polyethylene Bags

C₄ - Root Trainer Tray

T₁ to T₆ – Cocopeat : Perlite : Vermicompost

C₂ - PVC Pots

C₅ - Plastic Tray

T₇ – Sand : Soil : FYM (1:1:1)

C₃ -Plastic Basket

C₆ - Earthen Pots

Table 22: Effect of container size and growing media on dry weight of roots (g) in strawberry cv. Chandler

Media	Containers						Mean
	C ₁	C ₂	C ₃	C ₄	C ₅	C ₆	
T ₁ (1:1:1)	3.68	4.06	4.07	2.54	3.50	4.22	3.68
T ₂ (2:1:1)	5.02	5.64	5.17	3.88	5.50	5.41	5.10
T ₃ (3:1:1)	5.54	6.20	5.71	4.53	6.63	5.80	5.73
T ₄ (4:0:1)	4.33	4.34	4.61	3.03	4.10	4.97	4.23
T ₅ (4:1:0)	4.12	4.17	4.18	2.93	3.96	4.72	4.01
T ₆ (4:1:1)	4.82	4.58	5.05	3.16	4.28	5.16	4.51
T ₇ (1:1:1)	3.42	3.79	2.90	2.20	3.20	3.06	3.09
Mean	4.42	4.68	4.53	3.18	4.45	4.76	
SE ± m	T - 0.02 C- 0.01 T x C – 0.05						
C.D_(P = 0.05)	T - 0.05 C- 0.05 T x C – 0.14						

C₁- Polyethylene Bags

C₄ - Root Trainer Tray

T₁ to T₆ – Cocopeat : Perlite : Vermicompost

C₂ - PVC Pots

C₅ - Plastic Tray

T₇ – Sand : Soil : FYM (1:1:1)

C₃ -Plastic Basket

C₆ - Earthen Pots

Table 23: Effect of container size and growing media on average length of primary root (cm) in strawberry cv. Chandler

Media	Containers						Mean
	C ₁	C ₂	C ₃	C ₄	C ₅	C ₆	
T ₁ (1:1:1)	15.28	16.83	15.61	15.13	16.40	15.82	15.85
T ₂ (2:1:1)	17.26	18.34	17.64	17.10	18.05	17.92	17.72
T ₃ (3:1:1)	18.56	19.48	18.95	18.29	19.18	19.11	18.93
T ₄ (4:0:1)	16.12	17.76	16.51	15.78	17.57	17.08	16.80
T ₅ (4:1:0)	15.91	17.43	16.09	15.35	17.19	16.83	16.47
T ₆ (4:1:1)	16.42	18.14	16.91	16.07	17.86	17.43	17.14
T ₇ (1:1:1)	13.01	14.16	13.12	12.98	13.99	13.42	13.44
Mean	16.08	17.45	16.40	15.81	17.18	16.80	
SE ± m			T - 0.006	C - 0.006	T x C - 0.01		
C.D_(P = 0.05)			T - 0.02	C - 0.02	T x C - 0.04		

C₁- Polyethylene Bags

C₄ - Root Trainer Tray

T₁ to T₆ – Cocopeat : Perlite : Vermicompost

C₂ - PVC Pots

C₅ - Plastic Tray

T₇ – Sand : Soil : FYM (1:1:1)

C₃ -Plastic Basket

C₆ - Earthen Pots

Table 24: Effect of container size and growing media on average length of secondary root (cm) in strawberry cv. Chandler

Media	Containers						Mean
	C ₁	C ₂	C ₃	C ₄	C ₅	C ₆	
T ₁ (1:1:1)	3.15	3.55	3.23	2.83	3.47	3.28	3.25
T ₂ (2:1:1)	4.00	4.43	4.09	3.86	4.28	4.17	4.14
T ₃ (3:1:1)	4.28	4.71	4.36	4.16	4.60	4.42	4.42
T ₄ (4:0:1)	3.30	4.07	3.61	2.93	3.91	3.69	3.58
T ₅ (4:1:0)	3.19	3.84	3.42	3.10	3.64	3.52	3.45
T ₆ (4:1:1)	3.83	4.18	3.95	3.75	4.14	4.06	3.98
T ₇ (1:1:1)	2.87	3.27	2.93	2.66	3.14	3.01	2.98
Mean	3.51	4.00	3.65	3.33	3.88	3.73	
SE ± m			T - 0.005	C- 0.004	T x C – 0.01		
C.D_(P = 0.05)			T - 0.01	C- 0.01	T x C – 0.03		

C₁- Polyethylene Bags

C₄ - Root Trainer Tray

T₁ to T₆ – Cocopeat : Perlite : Vermicompost

C₂ - PVC Pots

C₅ - Plastic Tray

T₇ – Sand : Soil : FYM (1:1:1)

C₃ -Plastic Basket

C₆ - Earthen Pots

Table 25: Effect of container size and growing media on number of berries per plant in strawberry cv. Chandler

Media	Containers						Mean
	C ₁	C ₂	C ₃	C ₄	C ₅	C ₆	
T ₁ (1:1:1)	12.00	20.33	16.50	9.50	17.00	24.00	16.55
T ₂ (2:1:1)	20.00	28.83	23.50	18.50	24.66	31.500	24.50
T ₃ (3:1:1)	22.66	31.00	27.00	21.66	28.50	33.000	27.30
T ₄ (4:0:1)	15.83	23.00	19.50	14.00	21.50	27.167	20.16
T ₅ (4:1:0)	14.00	21.16	18.00	12.16	19.00	25.500	18.30
T ₆ (4:1:1)	17.66	24.66	22.00	15.66	23.00	29.167	22.02
T ₇ (1:1:1)	9.16	16.16	12.50	7.00	14.00	20.16	13.16
Mean	15.90	23.59	19.85	14.07	21.09	27.21	
SE ± m	T - 0.12 C- 0.11 T x C – 0.29						
C.D(P = 0.05)	T - 0.33 C- 0.31 T x C – 0.82						

C₁- Polyethylene Bags

C₄ - Root Trainer Tray

T₁ to T₆ – Cocopeat : Perlite : Vermicompost

C₂ - PVC Pots

C₅ - Plastic Tray

T₇ – Sand : Soil : FYM (1:1:1)

C₃ -Plastic Basket

C₆ - Earthen Pots

Table 26: Effect of container size and growing media on berry weight (g) in strawberry cv. Chandler

Media	Containers						Mean
	C ₁	C ₂	C ₃	C ₄	C ₅	C ₆	
T ₁ (1:1:1)	15.91	20.25	17.12	13.61	18.03	18.61	17.25
T ₂ (2:1:1)	14.50	18.22	16.44	12.45	16.90	17.46	15.99
T ₃ (3:1:1)	12.58	16.94	13.58	11.97	14.77	15.81	14.27
T ₄ (4:0:1)	11.60	15.13	12.23	10.58	13.44	14.39	12.89
T ₅ (4:1:0)	10.90	13.87	11.87	10.16	12.61	13.73	12.19
T ₆ (4:1:1)	11.53	15.31	12.56	11.14	13.92	14.93	13.23
T ₇ (1:1:1)	10.14	12.13	11.04	9.97	11.33	12.20	11.13
Mean	15.91	20.25	17.12	13.61	18.03	18.61	17.25
SE ± m	T - 0.02 C- 0.02 T x C – 0.06						
C.D(P = 0.05)	T - 0.07 C- 0.06 T x C – 0.17						

C₁- Polyethylene Bags

C₄ - Root Trainer Tray

T₁ to T₆ – Cocopeat : Perlite : Vermicompost

C₂ - PVC Pots

C₅ - Plastic Tray

T₇ – Sand : Soil : FYM (1:1:1)

C₃ -Plastic Basket

C₆ - Earthen Pots

Table 27: Effect of container size and growing media on berry breadth (cm) in strawberry cv. Chandler

Media	Containers						Mean
	C ₁	C ₂	C ₃	C ₄	C ₅	C ₆	
T ₁ (1:1:1)	3.42	4.27	3.67	3.12	3.80	4.04	3.72
T ₂ (2:1:1)	3.37	4.04	3.54	3.03	3.76	3.92	3.61
T ₃ (3:1:1)	3.25	3.85	3.44	2.87	3.63	3.73	3.46
T ₄ (4:0:1)	3.00	3.54	3.18	2.71	3.25	3.39	3.18
T ₅ (4:1:0)	2.81	3.44	2.95	2.65	3.06	3.17	3.01
T ₆ (4:1:1)	3.17	3.61	3.34	2.53	3.39	3.50	3.25
T ₇ (1:1:1)	2.70	3.11	2.80	2.29	2.93	3.05	2.81
Mean	3.10	3.69	3.27	2.74	3.40	3.54	
SE ± m			T - 0.03 C- 0.03	T x C – 0.09			
C.D_(P = 0.05)			T - 0.10 C- 0.09	T x C – 0.25			

C₁- Polyethylene Bags

C₄ - Root Trainer Tray

T₁ to T₆ – Cocopeat : Perlite : Vermicompost

C₂ - PVC Pots

C₅ - Plastic Tray

T₇ – Sand : Soil : FYM (1:1:1)

C₃ -Plastic Basket

C₆ - Earthen Pots

Table 28: Effect of container size and growing media on berry length (cm) in strawberry cv. Chandler

Media	Containers						Mean
	C ₁	C ₂	C ₃	C ₄	C ₅	C ₆	
T ₁ (1:1:1)	3.46	3.92	3.70	3.31	3.78	4.57	3.79
T ₂ (2:1:1)	4.03	4.55	4.14	3.90	4.31	4.74	4.28
T ₃ (3:1:1)	4.27	4.81	4.52	4.11	4.61	4.91	4.54
T ₄ (4:0:1)	3.89	4.27	3.91	3.73	4.15	4.46	4.07
T ₅ (4:1:0)	3.74	4.03	3.75	3.40	4.08	4.31	3.88
T ₆ (4:1:1)	4.13	4.44	4.19	3.91	4.34	4.68	4.28
T ₇ (1:1:1)	3.11	3.45	3.22	3.03	3.32	4.03	3.36
Mean	3.80	4.21	3.92	3.63	4.08	4.53	
SE ± m			T - 0.04 C- 0.04	T x C – 0.11			
C.D_(P = 0.05)			T - 0.13 C- 0.12	T x C – 0.33			

C₁- Polyethylene Bags

C₄ - Root Trainer Tray

T₁ to T₆ – Cocopeat : Perlite : Vermicompost

C₂ - PVC Pots

C₅ - Plastic Tray

T₇ – Sand : Soil : FYM (1:1:1)

C₃ -Plastic Basket

C₆ - Earthen Pots

Table 29: Effect of container size and growing media on total yield per plant (g) in strawberry cv. Chandler

Media	Containers						Mean
	C ₁	C ₂	C ₃	C ₄	C ₅	C ₆	
T ₁ (1:1:1)	248.35	421.50	324.28	191.31	367.30	450.51	333.88
T ₂ (2:1:1)	260.90	442.19	340.19	210.94	380.86	458.39	348.92
T ₃ (3:1:1)	280.30	459.41	354.30	236.20	399.60	464.30	365.69
T ₄ (4:0:1)	200.55	362.75	251.17	177.52	302.41	370.41	277.47
T ₅ (4:1:0)	190.57	340.29	230.10	151.24	289.12	355.20	259.42
T ₆ (4:1:1)	216.42	415.65	318.15	188.75	349.86	413.66	317.08
T ₇ (1:1:1)	146.56	180.04	168.56	132.58	171.42	270.28	178.24
Mean	220.53	374.55	283.82	184.08	322.94	397.54	
SE ± m			T - 0.006	C - 0.005	T x C – 0.01		
C.D_(P = 0.05)			T - 0.01	C - 0.01	T x C – 0.02		

C₁- Polyethylene Bags

C₄ - Root Trainer Tray

T₁ to T₆ – Cocopeat : Perlite : Vermicompost

C₂ - PVC Pots

C₅ - Plastic Tray

T₇ – Sand : Soil : FYM (1:1:1)

C₃ -Plastic Basket

C₆ - Earthen Pots

Table 30: Effect of container size and growing media on pH in strawberry cv. Chandler

Media	Containers						Mean
	C ₁	C ₂	C ₃	C ₄	C ₅	C ₆	
T ₁ (1:1:1)	2.34	2.98	2.40	2.18	2.77	2.51	2.53
T ₂ (2:1:1)	3.03	3.33	3.10	2.90	3.25	3.16	3.13
T ₃ (3:1:1)	3.20	3.48	3.27	3.11	3.41	3.32	3.30
T ₄ (4:0:1)	2.63	3.14	2.73	2.51	2.99	2.82	2.80
T ₅ (4:1:0)	2.45	3.05	2.49	2.32	2.91	2.67	2.65
T ₆ (4:1:1)	2.87	3.20	3.02	2.78	3.13	3.09	3.01
T ₇ (1:1:1)	2.21	2.93	2.33	2.13	2.60	2.42	2.44
Mean	2.67	3.16	2.76	2.56	3.01	2.86	
SE ± m			T - 0.005	C - 0.004	T x C – 0.01		
C.D_(P = 0.05)			T - 0.01	C - 0.01	T x C – 0.03		

C₁- Polyethylene Bags

C₄ - Root Trainer Tray

T₁ to T₆ – Cocopeat : Perlite : Vermicompost

C₂ - PVC Pots

C₅ - Plastic Tray

T₇ – Sand : Soil : FYM (1:1:1)

C₃ -Plastic Basket

C₆ - Earthen Pots

Table 31: Effect of container size and growing media on TSS (° Brix) in strawberry cv. Chandler

Media	Containers						Mean
	C ₁	C ₂	C ₃	C ₄	C ₅	C ₆	
T ₁ (1:1:1)	8.55	8.21	7.94	6.28	7.08	9.18	7.90
T ₂ (2:1:1)	8.83	8.62	8.26	7.01	7.41	9.63	8.29
T ₃ (3:1:1)	9.38	8.90	8.60	7.30	7.86	9.91	8.66
T ₄ (4:0:1)	8.71	8.44	8.07	6.82	7.21	9.57	8.14
T ₅ (4:1:0)	9.97	9.22	8.82	7.54	8.14	10.16	8.98
T ₆ (4:1:1)	9.16	8.78	8.31	7.17	7.66	9.81	8.48
T ₇ (1:1:1)	8.19	7.93	7.44	6.03	6.95	8.87	7.57
Mean	8.97	8.59	8.21	6.88	7.47	9.62	
SE ± m	T - 0.02 C- 0.02 T x C – 0.05						
C.D_(P = 0.05)	T - 0.06 C- 0.06 T x C – 0.16						

C₁- Polyethylene Bags

C₄ - Root Trainer Tray

T₁ to T₆ – Cocopeat : Perlite : Vermicompost

C₂ - PVC Pots

C₅ - Plastic Tray

T₇ – Sand : Soil : FYM (1:1:1)

C₃ -Plastic Basket

C₆ - Earthen Pots

Table 32: Effect of container size and growing media on TSS : Acid ratio in strawberry cv. Chandler

Media	Containers						Mean
	C ₁	C ₂	C ₃	C ₄	C ₅	C ₆	
T ₁ (1:1:1)	13.41	13.93	13.63	13.30	13.81	14.01	13.68
T ₂ (2:1:1)	13.06	13.42	13.12	12.92	13.22	13.48	13.20
T ₃ (3:1:1)	13.14	13.52	13.23	13.07	13.37	13.67	13.33
T ₄ (4:0:1)	12.53	13.03	12.68	12.29	12.83	13.12	12.74
T ₅ (4:1:0)	12.37	12.93	12.52	12.15	12.76	13.06	12.63
T ₆ (4:1:1)	12.72	13.17	12.84	12.57	13.08	13.31	12.95
T ₇ (1:1:1)	12.28	12.85	12.41	11.97	12.63	12.96	12.51
Mean	12.79	13.26	12.92	12.61	13.10	13.37	
SE ± m			T - 0.004 C- 0.004	T x C – 0.01			
C.D_(P = 0.05)			T - 0.01 C- 0.01	T x C – 0.03			

C₁- Polyethylene Bags

C₄ - Root Trainer Tray

T₁ to T₆ – Cocopeat : Perlite : Vermicompost

C₂ - PVC Pots

C₅ - Plastic Tray

T₇ – Sand : Soil : FYM (1:1:1)

C₃ -Plastic Basket

C₆ - Earthen Pots

Table 33: Effect of container size and growing media on Total Sugars (%) in strawberry cv. Chandler

Media	Containers						Mean
	C ₁	C ₂	C ₃	C ₄	C ₅	C ₆	
T ₁ (1:1:1)	5.65	6.85	5.91	4.98	6.47	6.14	6.00
T ₂ (2:1:1)	5.74	6.98	5.86	5.06	6.62	6.21	6.08
T ₃ (3:1:1)	6.42	7.53	6.78	5.74	7.24	6.96	6.77
T ₄ (4:0:1)	6.27	7.22	6.61	5.46	6.94	6.75	6.54
T ₅ (4:1:0)	5.89	7.03	6.17	5.22	6.76	6.42	6.24
T ₆ (4:1:1)	6.32	7.39	6.63	5.63	7.15	6.88	6.66
T ₇ (1:1:1)	5.03	6.30	5.12	4.95	6.22	5.86	5.58
Mean	5.90	7.04	6.15	5.29	6.78	6.46	
SE ± m			T - 0.02	C - 0.02	T x C – 0.05		
C.D(P = 0.05)			T - 0.06	C - 0.06	T x C – 0.15		

C₁- Polyethylene Bags

C₄ - Root Trainer Tray

T₁ to T₆ – Cocopeat : Perlite : Vermicompost

C₂ - PVC Pots

C₅ - Plastic Tray

T₇ – Sand : Soil : FYM (1:1:1)

C₃ -Plastic Basket

C₆ - Earthen Pots

Table 34: Effect of container size and growing media on reducing sugars (%) in strawberry cv. Chandler

Media	Containers						Mean
	C ₁	C ₂	C ₃	C ₄	C ₅	C ₆	
T ₁ (1:1:1)	4.68	5.01	4.84	4.42	4.91	5.20	4.84
T ₂ (2:1:1)	4.94	5.30	5.09	4.80	5.18	5.53	5.14
T ₃ (3:1:1)	5.41	5.72	5.48	5.18	5.61	5.86	5.54
T ₄ (4:0:1)	4.81	5.22	4.95	4.60	5.11	5.36	5.01
T ₅ (4:1:0)	4.48	4.94	4.70	4.23	4.80	5.03	4.70
T ₆ (4:1:1)	5.17	5.54	5.27	5.01	5.40	5.71	5.35
T ₇ (1:1:1)	4.28	4.86	4.52	4.10	4.73	4.96	4.57
Mean	4.82	5.23	4.98	4.62	5.10	5.37	
SE ± m			T - 0.003	C - 0.003	T x C – 0.01		
C.D_(P = 0.05)			T - 0.01	C - 0.01	T x C – 0.02		

C₁- Polyethylene Bags

C₄ - Root Trainer Tray

T₁ to T₆ – Cocopeat : Perlite : Vermicompost

C₂ - PVC Pots

C₅ - Plastic Tray

T₇ – Sand : Soil : FYM (1:1:1)

C₃ -Plastic Basket

C₆ - Earthen Pots

Table 35: Effect of container size and growing media on non-reducing sugars (%) in strawberry cv. Chandler

Media	Containers						Mean
	C ₁	C ₂	C ₃	C ₄	C ₅	C ₆	
T₁ (1:1:1)	1.28	1.79	1.34	1.20	1.56	1.43	1.43
T₂ (2:1:1)	2.42	3.19	2.65	2.27	3.08	2.98	2.76
T₃ (3:1:1)	3.06	3.63	3.14	2.97	3.36	3.20	3.23
T₄ (4:0:1)	1.79	2.26	1.99	1.55	2.12	2.04	1.96
T₅ (4:1:0)	1.45	2.03	1.63	1.36	1.99	1.73	1.70
T₆ (4:1:1)	2.04	2.53	2.13	1.96	2.37	2.21	2.24
T₇ (1:1:1)	1.15	1.52	1.22	1.10	1.42	1.29	1.28
Mean	1.88	2.45	2.01	1.77	2.27	2.12	
SE ± m	T - 0.005 C- 0.005 T x C – 0.01						
C.D(P = 0.05)	T - 0.01 C- 0.01 T x C – 0.03						

C₁- Polyethylene Bags

C₄ - Root Trainer Tray

T₁ to T₆ – Cocopeat : Perlite : Vermicompost

C₂ - PVC Pots

C₅ - Plastic Tray

T₇ – Sand : Soil : FYM (1:1:1)

C₃ -Plastic Basket

C₆ - Earthen Pots

Table 36: Effect of container size and growing media on ascorbic acid (mg per 100 g of fruit) in strawberry cv. Chandler

Media	Containers						Mean
	C ₁	C ₂	C ₃	C ₄	C ₅	C ₆	
T ₁ (1:1:1)	28.84	42.65	29.52	26.59	32.80	30.72	31.85
T ₂ (2:1:1)	42.90	51.28	45.80	42.12	48.76	46.83	46.28
T ₃ (3:1:1)	46.81	54.68	48.26	45.13	51.05	50.04	49.33
T ₄ (4:0:1)	35.07	46.02	37.80	33.74	40.95	41.49	39.18
T ₅ (4:1:0)	31.97	44.69	31.59	29.98	37.52	33.88	34.94
T ₆ (4:1:1)	39.73	49.53	40.97	37.64	35.34	43.16	41.06
T ₇ (1:1:1)	26.57	39.95	26.96	23.97	30.17	28.64	29.21
Mean	35.99	46.97	37.27	34.17	39.52	39.11	
SE ± m	T - 0.10 C- 0.10 T x C – 0.26						
C.D_(P = 0.05)	T - 0.01 C- 0.01 T x C – 0.02						

C₁- Polyethylene Bags

C₄ - Root Trainer Tray

T₁ to T₆ – Cocopeat : Perlite : Vermicompost

C₂ - PVC Pots

C₅ - Plastic Tray

T₇ – Sand : Soil : FYM (1:1:1)

C₃ -Plastic Basket

C₆ - Earthen Pots

Table 37: Cost and return analysis of strawberry plants planted in polyethylene bags and in different media combination

S. No.	Item of cost	C ₁ T ₁	C ₁ T ₂	C ₁ T ₃	C ₁ T ₄	C ₁ T ₅	C ₁ T ₆	C ₁ T ₇
1.	Cost of polyethylene bags (₹)	6	6	6	6	6	6	6
2.	Cost of cocopeat (₹)	86.40	90.00	122.40	162.00	162.00	151.20	-
3.	Cost of perlite (₹)	91.20	54.00	45.60	-	8.88	38.00	-
4.	Cost of vermicompost (₹)	17.76	11.10	8.88	8.88	-	7.40	-
5.	Cost of Soil (₹)	-	-	-	-	-	-	-
6.	Cost of FYM (₹)	-	-	-	-	-	-	3.60
7.	Cost of sand (₹)	-	-	-	-	-	-	-
8.	Cost of plants (₹)	12.00	12.00	12.00	12.00	12.00	12.00	12.00
9.	Labour charges (₹)	66.96	66.96	66.96	66.96	66.96	66.96	66.96
10.	Total	280.32	234.06	255.84	249.84	249.84	275.56	88.56
Return Structure								
1.	Yield per treatment (Kg)	1.5	1.6	1.7	1.2	1.1	1.3	0.88
2.	Price per kg	250.00	250.00	250.00	250.00	250.00	250.00	250.00
3.	Gross income (₹)	375.00	400.00	425.00	300.00	275.00	325.00	220.00
4.	Net Return (₹)	94.68	165.94	169.16	50.16	25.16	49.44	131.44
5.	Benefit Cost Ratio	1:1.34	1:1.70	1:1.66	1:1.20	1:1.10	1:1.17	1:2.48

*Cost is in Rupees.

Table 38: Cost and return analysis of strawberry plants planted in PVC pot and in different media combination

S.No.	Items of cost	C ₂ T ₁	C ₂ T ₂	C ₂ T ₃	C ₂ T ₄	C ₂ T ₅	C ₂ T ₆	C ₂ T ₇
1.	Cost of PVC pots (₹)	180.00	180.00	180.00	180.00	180.00	180.00	180.00
2.	Cost of cocopeat (₹)	72.00	108.00	126.00	187.20	187.20	144.00	-
3.	Cost of perlite (₹)	76.00	57.00	45.60	-	45.60	39.90	-
4.	Cost of vermicompost (₹)	14.80	11.10	8.88	48.84	-	1.82	-
5.	Cost of Soil (₹)	-	-	-	-	-	-	-
6.	Cost of FYM (₹)	-	-	-	-	-	-	3.15
7.	Cost of Sand (₹)	-	-	-	-	-	-	-
8.	Cost of Plants (₹)	12.00	12.00	12.00	12.00	12.00	12.00	12.00
9.	Labour Charges (₹)	66.96	66.96	66.96	66.96	66.96	66.96	66.96
10.	Total	421.76	435.06	439.44	495.00	491.76	444.68	344.22
Return structure								
1.	Yield per plant (Kg)	2.50	2.65	2.75	2.20	2.04	2.49	1.08
2.	Price per kg	250.00	250.00	250.00	250.00	250.00	250.00	250.00
3.	Gross income (₹)	625.00	662.50	687.50	550.00	510.00	622.50	270.00
4.	Net return (₹)	203.24	227.44	248.06	55.00	18.24	177.82	74.22
5.	Benefit Cost Ratio	1:1.50	1:1.52	1:1.56	1:1.11	1:1.04	1:1.40	1:0.78

*Cost is in Rupees.

Table 39: Cost and return analysis of strawberry plants planted in plastic basket and in different media combination

S.No.	Items of cost	C ₃ T ₁	C ₃ T ₂	C ₃ T ₃	C ₃ T ₄	C ₃ T ₅	C ₃ T ₆	C ₃ T ₇
1.	Cost of baskets (₹)	96	96	96	96	96	96	96
2.	Cost of cocopeat (₹)	57.60	86.40	103.68	136.80	136.80	108.00	-
3.	Cost of perlite (₹)	60.80	45.60	34.56	-	34.56	29.64	-
4.	Cost of vermicompost (₹)	11.84	8.88	7.10	7.10	-	5.80	-
5.	Cost of soil (₹)	-	-	-	-	-	-	-
6.	Cost of FYM (₹)	-	-	-	-	-	-	2.43
7.	Cost of sand (₹)	-	-	-	-	-	-	-
8.	Cost of plants (₹)	12.00	12.00	12.00	12.00	12.00	12.00	12.00
9.	Labour charges (₹)	66.96	66.96	66.96	66.96	66.96	66.96	66.96
	Total	305.20	315.84	320.30	318.86	346.32	318.40	177.39
	Return structure							
1.	Yield per treatment (Kg)	1.95	2.04	2.13	1.50	1.40	1.90	1.01
2.	Price per kg	250.00	250.00	250.00	250.00	250.00	250.00	250.00
3.	Gross income (₹)	487.50	510.00	532.50	375.00	350.00	475.00	252.50
4.	Net return (₹)	182.30	194.16	212.20	56.14	3.68	156.60	75.11
5.	Benefit cost ratio	1:1.60	1:1.62	1:1.66	1:1.20	1:1.01	1:1.50	1:1.42

*Cost is in Rupees.

Table 40: Cost and return analysis of strawberry plants planted in root trainer tray and in different media combination

S.No.	Items of cost	C4T1	C4T2	C4T3	C4T4	C4T5	C4T6	C4T7
1.	Cost of root trainer tray (₹)	420.00	420.00	420.00	420.00	420.00	420.00	420.00
2.	Cost of cocopeat (₹)	41.04	61.20	72.00	97.20	97.20	86.40	-
3.	Cost of perlite (₹)	43.32	31.92	27.36	-	25.08	22.80	-
4.	Cost of vermicompost (₹)	8.43	6.21	5.32	5.32	-	4.44	-
5.	Cost of soil (₹)	-	-	-	-	-	-	-
6.	Cost of FYM (₹)	-	-	-	-	-	-	1.80
7.	Cost of sand (₹)	-	-	-	-	-	-	-
8.	Cost of plants (₹)	12.00	12.00	12.00	12.00	12.00	12.00	12.00
9.	Labour charges (₹)	66.96	66.96	66.96	66.96	66.96	66.96	66.96
	Total	591.75	598.29	603.64	601.48	621.24	612.60	500.76
	Return structure							
1.	Yield per treatment (Kg)	1.15	1.27	1.42	1.06	1.01	1.13	0.80
2.	Price per kg	250.00	250.00	250.00	250.00	250.00	250.00	250.00
3.	Gross income (₹)	287.50	317.50	355.00	265.00	252.50	282.50	200.00
4.	Net return (₹)	-304.25	-280.79	-248.64	-336.48	-368.74	-330.10	-300.76
5.	Benefit cost ratio	1:0.48	1:0.53	1:0.60	1:0.44	1:0.41	1:0.46	1:0.40

*Cost is in Rupees.

Table 41: Cost and return analysis of strawberry plants planted in plastic tray and in different media combination

S.No.	Items of cost	C ₅ T ₁	C ₅ T ₂	C ₅ T ₃	C ₅ T ₄	C ₅ T ₅	C ₅ T ₆	C ₅ T ₇
1.	Cost of plastic tray (₹)	240.00	240.00	240.00	240.00	240.00	240.00	240.00
2.	Cost of cocopeat (₹)	86.40	118.80	180.36	190.80	218.16	150.72	-
3.	Cost of perlite (₹)	91.20	76.38	57.00	-	57.00	41.40	-
4.	Cost of vermicompost (₹)	17.76	14.87	11.10	11.84	-	8.62	-
5.	Cost of Soil (₹)	-	-	-	-	-	-	-
6.	Cost of FYM (₹)	-	-	-	-	-	-	4.50
7.	Cost of Sand (₹)	-	-	-	-	-	-	-
8.	Cost of Plants (₹)	12.00	12.00	12.00	12.00	12.00	12.00	12.00
9.	Labour Charges (₹)	66.96	66.96	66.96	66.96	66.96	66.96	66.96
	Total	514.32	529.01	567.42	521.60	594.12	519.70	323.46
	Return structure							
1.	Yield per treatment (Kg)	2.20	2.30	2.40	1.81	1.74	2.10	1.03
2.	Price per kg	250.00	250.00	250.00	250.00	250.00	250.00	250.00
3.	Gross income (₹)	550.00	575.00	600.00	452.50	435.00	525.00	257.50
4.	Net return (₹)	35.68	45.99	32.58	-69.10	-159.12	5.30	65.96
5.	Benefit cost ratio	1:1.07	1:1.09	1:1.06	1:0.87	1:0.73	1:1.02	1:0.80

*Cost is in Rupees.

Table 42: Cost and return analysis of strawberry plants planted in earthen pots and in different media combination.

S.No.	Items of cost	C ₆ T ₁	C ₆ T ₂	C ₆ T ₃	C ₆ T ₄	C ₆ T ₅	C ₆ T ₆	C ₆ T ₇
1.	Cost of earthen pots (₹)	210.00	210.00	210.00	210.00	210.00	210.00	210.00
2.	Cost of cocopeat (₹)	50.40	79.20	108.00	129.60	129.60	122.40	-
3.	Cost of perlite (₹)	53.20	45.60	34.20	-	34.20	34.20	-
4.	Cost of vermicompost (₹)	10.36	8.88	6.66	6.66	-	6.66	-
5.	Cost of Soil (₹)	-	-	-	-	-	-	-
6.	Cost of FYM (₹)	-	-	-	-	-	-	2.25
7.	Cost of Sand (₹)	-	-	-	-	-	-	-
8.	Cost of Plants (₹)	12.00	12.00	12.00	12.00	12.00	12.00	12.00
9.	Labour charges (₹)	66.96	66.96	66.96	66.96	66.96	66.96	66.96
	Total	402.92	422.64	437.82	425.22	452.76	452.22	279.21
	Return structure							
1.	Yield per treatment (kg)	2.70	2.80	2.81	2.22	2.13	2.50	1.62
2.	Price per kg	250.00	250.00	250.00	250.00	250.00	250.00	250.00
3.	Gross income (₹)	675.00	700.00	702.50	555.00	532.50	625.00	405.00
4.	Net return (₹)	272.08	277.36	264.68	129.78	79.74	172.78	125.79
5.	Benefit Cost Ratio	1:1.68	1:1.66	1:1.60	1:1.31	1:1.18	1:1.40	1:1.45

*Cost is in Rupees.

5.1 Effect of various growing media on growth, yield and quality of strawberry**5.1.1 Growth Parameters****5.1.1.1 Plant height**

It is evident from the data of the present investigation regarding the effect of different growing media on plant height of strawberry came to be significant as shown in Table 3 and was found that treatment T₃ (Cocopeat + Perlite + Vermicompost, 3:1:1) resulted in maximum plant height (22.09 cm) and the minimum plant height (14.76 cm) was observed in T₇ (control). The increase in plant height might be due to the presence of nutrients and sufficient pore spaces in coco-peat and perlite both having the properties of increases the cation exchange capacity, better distribution of moisture, water retention capacity, and better holding capacity of water and nutrients (Firoozabadi *et al.*, 2009; Por-Hossein *et al.*, 2009). The cocopeat and perlite both are also efficacious in root zonal area due to better reciprocate of the elements especially cations that affects root system and finally helps in improving the plant height (Nourizadeh, 2003). The influence of perlite and vermicompost on the plant height of strawberry may be attributed because of the activity of microbes present in vermicompost which helps in providing the availability of macro as well as micronutrients. The growing media treatments with a combination of perlite showed the increment of plant height revealed by Tabatabaei *et al.* (2006). These results were analogous with the earlier findings of Verdonck *et al.* (1981), Arancon *et al.* (2004), Tariq *et al.* (2013), Sharma and Godara (2017), and Thakur and Shylla (2018).

5.1.1.2 Plant Spread

The results depicted in Table 4 showed that the use of growing media in different types and sizes of containers brings out a significant effect on plant spread. The maximum plant spread (32.23 cm) was recorded in treatment T₃ (Cocopeat + Perlite + Vermicompost, 3:1:1) whereas a minimum (24.12 cm) was observed in the T₇ (control). This is due to the fact that perlite has high water absorption properties and better water efficiency (Djedidi *et al.*, 1999; Inden and Torres, 2004), and on the other hand, vermicompost is an effectual growing media that consists of

accessible forms of nutrition for plant uptakes such as exchangeable phosphorus, nitrates, calcium, magnesium and potassium and emphasized plant canopy (Khalighi and Padasht-Dehkaee, 2000; Fernandes and Eduardo-Cora, 2004). Cocopeat along with perlite provides better aeration, moisture retention capacity, and nutrient availability to the plant. Hesami *et al.* (2012) also concluded that the treatment with the combination of soilless substrate i.e perlite + cocopeat recorded the highest plant spread. Similar results were reported by Ameri *et al.* (2012) and in their results, the maximum plant spread was observed in 50% cocopeat + 50% perlite and 5% vermicompost + 45% perlite + 50% cocopeat in Camarosa. Also, these results were in conformity with Singh *et al.* (2008) and Sharma and Godara (2017).

5.1.1.3 Survival Percentage

It is evident from Table 5 that all soilless media improved the survival percent of plants compared to the control. The maximum survival percentage (88.89%) was recorded in T₃ (Cocopeat + Perlite + Vermicompost, 3:1:1) whereas, the minimal survival percent (66.67%) was noted in T₇ (control). This is because of the properties of growing media which helped in maintaining the moisture around the root zonal area and strengthened the root system which ultimately provides a better survival rate for strawberry plants (Schie, 1999). The growing media with ratio 3:1:1 (cocopeat + perlite + vermicompost) reported better survival percentage which was also analogous with the results of Rai *et al.* (2014) and was in conformity with the earlier findings of Nourizadeh (2003), Medina *et al.* (2007), Haddadi *et al.* (2010), and Sharma and Godara (2017).

5.1.2 Shoot Parameters

5.1.2.1 Shoot length

The data mentioned in Table 6 showed that the effect of growing media and container size on shoot length came to be significant. It was reported that treatment T₃ (Cocopeat + Perlite + Vermicompost, 3:1:1) resulted in maximum (17.50 cm) shoot



Plate 4: (a) Crop at reproductive stage



Plate 5: (b) Crop at reproductive stage

length and the lowest shoot length (11.93 cm) was observed in T₇ (control). This is due to the fact that vermicompost provides a better growth medium for plant establishment and has the better diffusion of oxygen and provide support to fast grown of the shoot parts of the plant due to availability of better nutrition with water in root zonal area. Vermicompost exhibited significant impact on growth characteristics due to the synergistic combination in enhancing the physical state of the growing media and nutritional factors (Sahni *et al.*, 2008). Similar result was revealed by Abad *et al.* (2002) and Awang *et al.* (2009).

5.1.2.2 Crown Diameter

The results depicted in Table 7 showed that the use of growing media brings out a significant effect on crown diameter in strawberry and the maximum was obtained in media T₃ (19.64 mm), on the contrary minimum (14.58 mm) was observed in the T₇ (control). The increment in diameter of crown might be due to the fact that volume of substrate which provides accessibility of water and nutrients and also helps in improving the aeration condition which strengthens the root system, maintains the translocation of nutrients in the shoot system and also influences the capturing of light (Du *et al.*, 2007). These findings were similar to the results of Tehranifar *et al.* (2007) who reported higher crown diameter in cocopeat as compared to media with sand. Also, these findings are in conformity with Sharma and Godara (2017).

5.1.2.3 Number of runners per plant

The perusal of data presented in Table 8 revealed that the number of runners per plant came to be a significant in response to the use of different growing media. The maximum number of runners per plant (34.72) was produced by treatment T₃ (Cocopeat + Perlite + Vermicompost, 3:1:1), whereas a minimum (19.97) was observed in the T₇ (control). These results are in line with the findings of Joshi (2003) who reported that the perlite having properties like better aeration, helps in translocation of nutrients in the shoot system and due to this reason the production of runners is found to be maximum in growing media with perlite combination. Shylla and Sharma (2014) also concluded that the maximum number of runners were produced when perlite was used as a growing media as compared to control (soil).

5.1.2.4 Runners length

The data mentioned in Table 9 showed that the effect of growing media and container size on the length of the runner came to be significant. It was reported that treatment T₃ (Cocopeat + Perlite + Vermicompost, 3:1:1) resulted maximum (55.27 cm) runner's length, while the minimum runner's length (43.96 cm) was observed in the T₇ (control). These findings were also similar to Ercisli *et al.* (2004), as they observed significant effect of growing media on runner's length and better results were obtained from peat and perlite media because it has a property of better aeration and low tension in water potentials. Sharma and Godara (2017) also reported that the runners length was maximum in soilless growing media (cocopeat + perlite + vermicompost) and minimum runner's length was found in control (sand + soil + FYM). Thakur and Shylla (2018) concluded that the length of runners was influenced by growing media under perlite combination with the excellent feature of ameliorating the growth and high water retention capacity (Djedidi *et al.*, 1999 and Inden and Torres 2004).

5.1.2.5 Fresh and dry weight of shoot

The perusal data given in Table 10 and 11 resulted that the growing media showed a significant impact on the fresh and dry weight of shoot in strawberry. The treatment T₃ (Cocopeat + Perlite + Vermicompost, 3:1:1) reported maximum fresh and dry weight of shoot (6.98 g and 1.50 g), whereas minimum (4.77 g and 0.71 g) fresh weight of shoot and dry weight of shoot was observed in T₇ (control), respectively. This is because the soilless growing media has a property of retaining more water, maintains density as well as porosity, which plays a vital role in strawberry cultivation (Ameri *et al.*, 2012). Sharma and Godara (2017) concluded that the soilless media affects on biomass of the strawberry plant and correspondingly observations were noted by Al-Raisy *et al.* (2010) in cv. Camarosa. Also, these findings were in conformity with Ercisli *et al.* (2005).

5.1.3 Leaf Parameters

5.1.3.1 Number of leaves per plant

The data on the number of leaves per plant recorded in Table 12 varied significantly in response to the use of different growing media and container sizes. The highest number of leaves per plant (19.52) was produced by growing media treatment T₃, whereas a minimum (10.86) was

observed in the T₇ (control). The number of leaves mostly depended on the different types of soilless growing media (Bartczak *et al.*, 2007) and was found maximum in growing media combination of peat alongwith cocopeat contrasted to sand and perlite (Tehranifar *et al.*, 2007). Selda and Anapali (2010) observed that the leaf number decreased as the soil was added to the growing media. These findings are also conformity with Hassan *et al.* (2011) who reported that coconut husks produced the maximum number of leaves and Hesami *et al.* (2012) also observed that the highest number of leaves was reported in perlite compared to the mixture. Shylla and Sharma (2014) reported that the maximum number of leaves was found when cv. Chandler was grown under protected conditions using perlite as a growing media. These results were analogous with the earlier findings of Sharma and Godara (2017) and Thakur and Shylla (2018).

5.1.3.2 Leaf area (cm²)

It is noticeable from the data presented in Table 13 that the variation with respect to leaf area among different growing media and containers was found to be significant during the present studies. The data revealed that treatment T₃ (Cocopeat + Perlite + Vermicompost, 3:1:1) recorded the maximum leaf area (132.29 cm²), and it was significantly superior to all other treatments. This is due to the fact that perlite and vermicompost based media both having high and low density due to available essential nutrients to plants and peat also show more pronounced effects on leaf area of strawberry in a greenhouse as compared to all other substrates (Tariq *et al.*, 2013). Thakur and Shylla (2018), also observed that leaf area was significantly increased by different growing media combinations as compared to control, however, plants grown in perlite and FYM with equal proportion depicted the highest leaf area expansion in comparison to other treatments. Similar results were reported by Khan *et al.* (2002) who observed maximum leaf area when gladiolus flowers were grown in media containing perlite and farm yard manure. These results were in conformity with Singh *et al.* (2008), Ameri *et al.* (2012), Roosta and Afshaaripoor (2012), and Khalid *et al.* (2013).

5.1.3.3 Petiole length (cm)

The data related to the effect of different growing media and container size on petiole length are presented in Table 14. The maximum petiole length (9.53 cm) was found in T₃ treatment (Cocopeat + Perlite + Vermicompost, 3:1:1) and the minimum petiole length (5.41 cm)

was found in T₇ (control). Tehranifar *et al.* (2007) reported significantly higher petiole length from 100 percent cocopeat (96.06 mm) compared to the 100 per cent sand (89.21 mm). Sharma and Godara (2017) observed the maximum petiole length in cocopeat + perlite + vermicompost (3:1:1), whereas, minimum growth was noted in control. These results are in line with Tehranifar *et al.* (2007), Ameri *et al.* (2012), and Sharma and Godara, (2017).

5.1.3.4 Fresh and Dry weight of leaves (g)

From the data presented in Table 15 and 16, it is clear that the differences among the various growing media were reported to be significant in respect of the fresh weight of leaves. The maximum fresh weight of leaves (2.53 g) was observed in T₃ (Cocopeat + Perlite + Vermicompost, 3:1:1). However, the minimum fresh weight of leaves (1.37 g) was recorded under T₇ (control). It was also apparent from the data that the treatment T₃ produced a maximum dry weight of leaves (1.31 g) whereas, minimum dry weight of leaves (0.80 g) was observed in the T₇ (control). This is because soilless media affects the biomass of the strawberry as concluded by Sharma and Godara (2017). Also, they have properties like water retention capacity, maintaining density, and porosity which play a key role in the cultivation (Ameri *et al.*, 2012). These results were in conformity with Ercisli *et al.* (2005) and Al-Raisy *et al.* (2010).

5.1.3.5 Leaf chlorophyll content

The data in Table 17 revealed that the leaf chlorophyll content came to be significant in response to the use of different growing media and container sizes. It was found that treatment T₃ (Cocopeat + Perlite + Vermicompost, 3:1:1) resulted in maximum leaf chlorophyll content (41.12 %) and the minimum leaf chlorophyll content (32.74 %) was observed in T₇ (control). This is because the amount of chlorophyll content is influenced by nutrient availability as cocopeat, perlite, and vermicompost media are rich in nutrients. Thus, resulting in more accumulation of photosynthates. Perlite provides proper environment for cultivation as it has properties of interchanging gases in soil and ultimately improves the root zone environment. The growing media helps in improving the aeration condition, which strengthened the root system, maintained the translocation of nutrients in the shoot system and also influenced the capturing of light (Du *et al.*, 2007). These results were similar to Ebrahimi *et al.* (2012), Subraya (2015), Choudhari (2015) and Godwa (2017).

5.1.4 Flower Parameters

5.1.4.1 Days taken first flower to produce

It is apparent from the data given in Table 18, that the differences among the various growing media and container size were noted to be vital in respect of days taken to initiate the first flower. It was found that T₃ (Cocopeat + Perlite + Vermicompost, 3:1:1) took minimum days (78.72) for the first flower to open and the maximum days (110.36) required for the first flower to open was observed under T₇ (control). This is because vermicompost leads to early onset of reproductive stage resulting in the increase in photosynthates production due to the presence of phosphorous (Odongo *et al.*, 2008). The flowering was affected by growing media and it was observed that flowers bloomed earlier in soilless media as compared to soil based cultivation system which was reported by Albaho *et al.* (2008). Strawberry plants grown in leaf manure based growing media required a minimum (82.67 days) days to open the first flower, while plants grown in poultry manure based growing media took maximum days (101 days) to open the first flower. Growing media produced larger (1.9 cm) and the highest number of flowers (96) compared to other substrates (Ayesha *et al.*, 2011). These findings were in conformity with Godwa (2016), Sharma and Godara (2017), and Thakur and Shylla (2018).

5.1.4.2 Duration of flowering

The data in Table 19 clearly indicates that there is a significant influence of different growing media and container sizes on the duration of flowering. The maximum duration of flowering (62.19 days) was observed under T₃ (Cocopeat + Perlite + Vermicompost, 3:1:1) whereas, the minimum duration of flowering (48.75 days) was observed under T₇ (control). This is because the physical and chemical properties of the growing media produce their effect on plant growth and flowering (Wilkerson, 2002). These observations were in conformity with Godwa (2016) and Thakur and Shylla (2018).

5.1.4.3 Number of flowers per plant

The data pertaining to the number of flowers per plant is tabulated in Table 20. It is noticeable from the data that the growing media and container size showed a significant impact

on the number of flowers per plant in strawberry. It was apparent from the data that the media T₃ (Cocopeat + Perlite + Vermicompost, 3:1:1) produced a maximum number of flowers per plant (29.08) whereas a minimum number of flowers per plant (15.88) was observed in T₇ (control). This is because vermicompost with perlite increases the photosynthetic rate which resulted in a break of bud dormancy and improved flowering (Prasad, 2017). Villagra *et al.* (2012) reported that the number of flowers differed significantly with different cultivation systems, where maximum flowers were found in plants grown with a conventional system (3.605, soil) compared to soilless culture system in vertical sleeves (2.813). Sharma and Godara (2017) also reported that the total number of flowers (28.67 and 33.93) per plant were obtained from the plants grown in S₂ (cocopeat + perlite + vermicompost, 3:1:1), which was more or less statistically at par with S₁ (cocopeat + perlite + vermicompost, 2:1:1). These observations were analogous with Godwa (2016), and Sharma and Godara (2017).

5.1.5 Root Parameters

5.1.5.1 Fresh and dry weight of root (g)

The perusal of data given in Table 21 and 22 revealed that the growing media and container size yielded a significant effect on the fresh weight of shoot in strawberry and reported that the media T₃ (Cocopeat + Perlite + Vermicompost, 3:1:1) reported



Plate 6: Effect of growing media on average length of roots of strawberry cv. Chandler



Plate 7: Crop at fruit bearing stage

maximum root fresh weight (8.83 g) whereas minimum root fresh weight (6.85 g) was observed in T₇ (control). On the other hand, the maximum dry weight of root of (5.73 g) was observed under T₃ treatment (Cocopeat + Perlite + Vermicompost, 3:1:1) and the minimum dry weight of root of 3.09 g was observed in T₇ (control). This is due to the fact that humic acid provides plant nutrient and water uptake, differentiation of cells, and lateral root formation (Jindo *et al.*, 2012). Madhavi *et al.* (2021) reported that the highest fresh and dry root weight in the vegetative stage was recorded in T₂ (18.00 g) followed by T₁ (13.52 g) and T₃ (11.15 g). Similar results were found by Hasnain *et al.* (2020) and Madhavi *et al.* (2021).

5.1.5.2 Average length of primary and secondary roots (cm)

The data in Table 23 and 24 reveals that the effect of growing media and container size on the average length of primary roots came to be significant. It was reported that treatment T₃ (Cocopeat + Perlite + Vermicompost, 3:1:1) resulted in the maximum length of primary roots (18.93 cm) and the minimum length of primary roots (13.44 cm) was observed in T₇ (control). In the case of secondary roots, it was reported that the treatment T₃ produced a maximum length of secondary roots (4.42 cm) whereas, minimum length of secondary roots (2.98 cm) was observed in T₇ (control). This was because the length of the root might be influenced by the physical properties of substrates (Bengough *et al.*, 2006). Soilless cultivation provides a better exchangeable capacity of elements especially cations inside the growing media and supply moisture evenly around the root zonal area and affects root system formation (Nourizadeh, 2003). The increment in the length of root of strawberry in the soilless cultivation system as compared to conventional system was also reported by Ebrahimi *et al.* (2012) and Sharma and Godara (2017).

5.1.6 Fruit parameter

5.1.6.1 Number of berries per plant

The perusal of data presented in Table 25 revealed that the number of berries per plant recorded varied significantly in response to the use of different growing media and container sizes. The maximum number of berries per plant (27.30) was produced by T₃ (Cocopeat + Perlite + Vermicompost, 3:1:1) whereas a minimum (13.16) was observed in T₇ (control). This is may be due to the accumulation of starch, carbohydrates, and photosynthates provided by

vermicompost and perlite which leads to an increase in fruit set and thereby increasing the number of berries (Godwa, 2016). The suitable atmosphere in root zonal area in soilless substrate leads to variation in number of berries (Ebrahimi *et al.*, 2012; Ericisli *et al.*, 2005; Mashadi *et al.*, 2009; Serrano *et al.*, 1993). They also revealed that the combination of different growing media most probably provided a better atmosphere for root growth and prevents tension in water and produced more number of berries in strawberry.

5.1.6.2 Berry weight (g)

From the data presented in Table 26, it is resulted that the differences among the various growing media were reported to be significant in respect of berry weight. The maximum berry weight (17.25 g) was observed in T₁ treatment. However, minimum berry weight (11.13 g) was recorded under T₇ (control). This is maybe due to the reason that substrates provide a balanced amount of macro as well as micronutrients and also help in the production of more synthase due to the physiocochemical status of media combination and synthesis of contents such as carbohydrates resulting in the more weight of the strawberry fruit (Sharma and Godara, 2017). The current results are also in agreement with Ogendo *et al.* (2008), Ayeni *et al.* (2009), and Ayesha *et al.* (2011).

5.1.6.3 Berry length and breadth (cm)

It is evident from the data presented in Table 27 and 28 that the variation with respect to berry breadth among different growing media and containers was significant during the present studies. The data showed that T₁ recorded the maximum berry breadth (3.72 cm). The minimum berry breadth (2.81 cm) was observed under control T₇ which was significantly different from all other treatments. It is evident from the data that the maximum berry length (4.54 cm) was recorded in T₃ whereas, minimum berry length (3.36 cm) was observed in the T₇ (control). This may be due to the better physical conditions, proper holding of moisture and aeration properties of growing media. According to Sharma and Godara (2017), all combinations of soilless substrates



Plate 8: Effect of growing media on length and breadth of strawberry cv. Chandler

significantly increased the fruit length and breadth compared to control. The present investigations are supported with the results of Fornes *et al.* (2003) and Ayesha *et al.* (2011), who observed that the maximum size of fruit was found in manure based medium, which may be due to its ability to provide essential micronutrients to the plants. Ullah *et al.* (2008) and Gungor and Yildirim (2013) also reported similar results and concluded that the combination of growing media significantly increased the length and diameter of fruit as compared to peat alone.

5.1.6.4 Total yield per plant (g)

From the data presented in Table 29, it is clear that the differences among the various growing media were reported to be significant in respect of total yield per plant. The maximum (365.69 g per plant) yield per plant was recorded in T₃ and the minimum (178.24 g) yield per plant was recorded under T₇ (control). The soilless growing media had been reported to improve the aeration, better root system formation (Yuan *et al.*, 1996; Verdonck and Demeyer, 2004), which finally resulted in higher yield (Du *et al.*, 2007; Albaho *et al.*, 2009). These findings are also in consonance with Gracia and Deverde (1994) and Maher *et al.* (2008), who reported that the development of roots was quicker in soilless culture and gives better yield. According to Sharma and Godara (2017), the soilless substrate provides the most appropriate conditions for vegetative growth, which resulted in better yield in strawberry. Economakis and Krulj (2001) and Waffa *et al.* (2009) also recorded similar results and concluded that the increment of vegetative growth in soilless substrate gave more yield as compared to soil. These results are in line with the observations of Linardakis and Manios (1990); Cantliffe *et al.* (2008); Yavari *et al.* (2008); Mashadi *et al.* (2009) and Rostami *et al.* (2014) and they also reported that the yield of strawberry significantly varied by soilless growing media composed of different ratios of cocopeat, perlite, pumice, vermicompost, sawdust, and zeolite. The results of the present study are also in confirmation with the findings of Atiyeh *et al.* (2000), Arancon *et al.* (2004), Edwards and Burrows, (1988); Abad *et al.* (2002); Cantliffe *et al.* (2007) and Singh *et al.* (2010).

5.1.7 Biochemical Parameters

5.1.7.1 pH

The data pertaining to pH is tabulated in Table 30. It was apparent from the data that the treatment T₃ produced maximum pH (3.13), whereas, minimum pH (2.44) was observed in T₇ (control). This is because the soilless growing media changed the physical and chemical properties, also converted higher amounts of organic acids and photosynthates into sugars during the fruit ripening stage and thereby affecting the quality characteristics especially pH in strawberry. Since the pH of a growing medium is influenced by the substrate: solution ratio, volume of medium used as well as soluble salts. Also, Asghari (2014) reported that different media increased the pH content in strawberry.

5.1.7.2 Total soluble solids (°Brix)

The perusal of data presented in Table 31 revealed that the TSS in strawberry varied significantly in response to the use of different growing media and container sizes. The maximum TSS (8.98 °Brix) was produced by treatment T₅, whereas the minimum (7.57 °Brix) TSS was observed in the T₇ (control). These results might be due to the fact that cocopeat, perlite, and vermicompost enhanced TSS due to the presence of macro and micronutrients of media. The presence of K improves vegetative growth and also promotes sugar accumulation, which ultimately yields higher TSS. Tehranifar *et al.* (2007) revealed that the maximum soluble solid percentage (9.5%) from the strawberry plant grown with 100 per cent perlite as compared to the combination of growing media. Jafarnia *et al.* (2010) reported that higher percentage of total soluble solid from the combination of perlite and peat moss than 100 percent perlite. These present findings are in conformity with (Sharma and Godara, 2017) and according to them, the maximum TSS (7.29%) was noted in S₆ (cocopeat + perlite + vermicompost, 3:1:1) followed by S₂ (7.09%) and the minimum TSS (6.38%) was recorded in the fruits obtained from the soil. Similar kind of results was obtained in strawberry by Ghazvini *et al.* (2007), and Ameri *et al.* (2012).

5.1.7.3 TSS: Acid ratio

The data pertaining to the TSS: Acid ratio is tabulated in Table 32. It was apparent from the data that the treatment T₁ produced maximum TSS: Acid ratio (13.68), whereas, the minimum TSS: Acid ratio (12.51) was observed in T₇ (control). Sharma and Godara (2017)

concluded that the higher TSS/ acidity ratio (10.11 and 9.60) was observed from different combination of growing media during 2013-14 and 2014-15 respectively and the lowest TSS/ acid ratio (7.36 and 7.28) was observed from control. This is because the soilless growing media changed the physical and chemical properties, also converted higher amounts of organic acids and photosynthates into sugars during the fruit ripening stage and thereby affecting the quality of strawberry. These results are also conformity to findings of Inden and Torres (2004), Jafarnia *et al.* (2010) and Ameri *et al.* (2012).

5.1.7.3 Total sugars (%)

From the data presented in Table 33, it is evident that the differences among the various growing media were found to be significant in respect of total sugars. The maximum total sugars (6.77%) were observed in T₃ treatment and minimum total sugars (5.58 %) were recorded under T₇ (control). This is might be due to the soilless growing media having a property of accumulation of sugars and metabolites in fruits, which ultimately increased the sugars in berries (Sharma and Godara, 2017). These results were analogous with the findings of Thakur and Shylla (2018) who revealed that the total sugars were maximum (7.49 %) under perlite + FYM treatment.

5.1.7.4 Reducing and non-reducing sugars (%)

The data in Table 34 and 35 revealed that the reducing sugars came to be significant in response to the use of different growing media and container sizes. It was found that treatment T₃ resulted in maximum reducing sugars (5.54 %) and the minimum reducing sugars (4.57 %) was observed in T₇ (control) and in Table 35 treatment T₃ (3.23 %) was found to be maximum non-reducing sugars and minimum (1.28 %) was observed in T₇ (control). This is because soilless growing media had been reported to improve aeration, root system formation, also the synthesis of the contents of carbohydrates resulting in the improvement of sugars in strawberry fruit. According to Sharma and Godara (2017), soilless substrate significantly increased the reducing sugars content of fruits compared to all treatments. These results were in conformity with Thakur and Shylla (2018) who concluded that the maximum reducing sugars (5.38 %) were found in fruits harvested from perlite + FYM treatment and the highest non-reducing sugars (1.80 %) were observed under perlite as well as perlite + FYM treatment, both of which were statistically at par

with cocopeat + FYM and perlite + cocopeat + FYM treatments. These results are also similar with the results of Paraskevopoulou *et al.* (1990) and Vassilakakis *et al.* (1991).

5.1.7.5 Ascorbic acid (mg per 100 g of fruit)

The data pertaining to ascorbic acid is tabulated in Table 36. It was apparent from the data that the treatment T₃ produced maximum ascorbic acid (49.33 mg per 100 g of fruit), whereas, minimum ascorbic acid (29.21 mg per 100 g of fruit) was observed in T₇ (control). This might be due to the physicochemical properties of growing media which alter by mixing of organic (cocopeat and vermicompost) and inorganic (perlite) substrates, resulting in the synthesis of vitamin C and thereby improving fruit quality. These observations are in conformity with the results of Yavari *et al.* (2008) and Hassan *et al.* (2011), who also revealed that the highest vitamin C content in the fruits produced using coconut husk and lowest under soil cultivation. Similar results were obtained by Choudhari (2015) and Godwa (2016).

5.2 Effect of Container Size on Vegetative Growth

Container and its size influence the vegetative growth of the strawberry plant and its performance. Plants undergo many changes like physiologically as well as morphologically in response to decreased rooting volume. It also plays a vital role in biomass accumulation and partitioning, photosynthesis, leaf chlorophyll content, plant water relations, translocation of nutrients, transpiration, flowering, and yield all are influenced by restriction of roots and size of the container (NeSmith and Duval, 1998). Amongst the different containers used, the maximum plants height (20.96 cm), plant spread (31.21 cm), shoot length (16.40 cm), crown diameter (18.56 mm), number of



Plate 9: Strawberry plants in PVC Pot



Plate 10: Strawberry plants in Plastic Tray

runner per plant (34.83), runners length (53.42 cm), fresh weight of shoot(6.65 g), dry weight of shoot (1.20 g), number of leaves per plant (19.59), leaf area (131.19 cm²), average length of primary roots (17.45 cm), average length of secondary roots (4.00 cm), fresh weight of roots (8.42 g), dry weight of root (4.68 g), petiole length (8.94 cm), fresh weight of leaves (2.37 g), dry weight of leaves (1.22 g), leaf chlorophyll content (39.87 %) was observed in C₂ and also maximum dry weight of roots (4.76 g) was reported in C₆ whereas minimum plant height (18.30 cm) was observed in C₁ and minimum plant spread (27.78 cm), shoot length (15.42 cm), crown diameter (16.91 mm), number of runners per plant (22.76), fresh weight of shoot (5.83 g) dry weight of shoot (0.90 g), number of leaves per plant (10.76), leaf area (119.05 cm²) petiole length (7.14 cm), fresh weight of leaves (1.88 g) dry weight of leaves (0.84 g) leaf chlorophyll content (35.07 %), average length of primary roots (15.81 cm), average length of secondary roots (3.33 cm) fresh weight of roots (7.22 g) was observed in C₄ and on the other hand, minimum runners length (40.73 cm) was reported in C₆. This is maybe due to the fact that roots are mostly dependent on plant aerial portions for photosynthates and hormones. According to Peterson *et al.* (1991), roots get confined in a container which restricts growth as the plant competes for essential resources and gives pronounced effect on moisture of soil content and aeration. Shoot growth also gets impacted by varying container sizes. Height of shoot and reduction in biomass observed in a small container in tomato by restriction of roots and decreased partitioning to the leaves. The negligible evaporative cooling in the case of PVC pots results in the higher temperature of the rooting media, which ultimately shows better root and shoot growth of the plant in the winter month (Sharma and Godara, 2017). Manole *et al.* (2008) had also concluded that there is significant effect of container type on the biological activity of growing media and plant growth. These findings are in conformity with Cantliffe *et al.* (2001) and Dafaault and Waters (1985), who have also revealed that the effect of type of growing containers on strawberry plant growth. Paroussi *et al.* (1995) concluded the strawberry plants grown in white plastic containers produced the highest leaf number and also produce a maximum fresh and dry weight of plant under soilless perlite media. The present investigation is analogous with the observations of Dafaault and Waters (1985) and Durner *et al.* (2002). Similar results were observed by Sirin and Sevgican (1999), they found the bags with wider breadth give more chance for increasing the activity of roots in the upper parts of the black bags resulting in better growth of cucumber. Present investigations are also in conformity with the earlier findings of

NeSmith and Duval (1998) and Cantliffe *et al.* (2001) who cultivated strawberry under soilless culture.

5.3 Effect of Container Size on Reproductive Growth

The present investigation reported that the minimum days (84.36) for the first flower to open, number of flowers per plant (29.47), number of berries per plant (27.21), berry length (4.53 cm) and maximum total yield per plant (397.54 g) was observed in C₆, and longest duration of flowering (62.81), berry weight (15.98 g) and berry breadth (3.69 cm), was found in C₂ container. This is because of the effect of cooling and proper diffusion of gas given by the earthen pots which result in better flowering than other types of pot. The results of the present investigation are in line with the observations of Santos *et al.* (2012) who reported similar results in hybrids of wild passion fruit and Pawar *et al.* (2005) also revealed better flowering in earthen pots in chrysanthemum flower. The likeness in the reproductive growth in different containers may be because the behavior of flowering is dependent on the environmental conditions. The observations of the present study are in conformity with Phala *et al.* (2012), who also evaluated that the number of inflorescence increased due to size of different growing media bags. However, interaction studies, the size of container caused difference in reproductive growth significantly. This is due to the fact that the size of the container, the size of the plant and the temperature condition, which can influence early flowering and yield (Bish and Cantliffe, 2000; Bish *et al.*, 2002; Bish *et al.*, 2003). The increment in yield characteristics due to the reason of better thermal insulating/ cooling property of the earthen pots and kept temperatures of root when the temperature of air exceeded 35°C, which increased the duration of flowering up to one or two weeks. The results are similar to the findings of Ithape and Bhamare (2011), who reported the plants grown in earthen pots produced higher yield and increased the shelf life of different vegetables. Similar results was also reported by Sharma and Godara (2017).



Plate 11: Strawberry plants in Plastic Basket



Plate 12: Strawberry plants in Earthen pot



Plate 13: Strawberry plants in Root trainer tray



Plate 14: Strawberry plants in Polyethylene bag

5.4 Effect of Container Size on Biochemical Parameters

The biochemical characteristics of strawberry plants were significantly influenced due to the response of different container and their size. The maximum pH (3.16), TSS (9.62 °Brix), TSS: Acid ratio (13.37), reducing sugars (5.37 %) was reported in C₆ and maximum total sugars (7.04 %), non-reducing sugars (2.45 %) and ascorbic acid (46.97 mg per 100 g of fruit) was observed in C₄. However, the minimum pH (2.67) in C₁, TSS (6.88 Brix), TSS:Acid ratio (12.61), total sugars (5.29 %), reducing sugars (4.62 %) non-reducing sugars (1.77 %) ascorbic acid (34.17 mg per 100 g of fruit) was reported in C₄. Sharma and Godara (2017) reported maximum TSS (7.31% and 7.24%), TSS/ acid ratio (9.94 and 9.48), total sugar (6.10% and 5.98%), reducing sugar (5.07% and 4.97%) in strawberry plants planted in earthen pots. These findings are more or less similar to the results of Hassan *et al.* (2011), who also reported that the quality characteristics in a strawberry were significantly affected by different containers. This may be due to the fact that the proper moisture and nutrition gave better fruit growth and also the quality of the fruits which ultimately depending on the genetic potentiality of the strawberry plants. The information compiled revealed that the container size showed significant a effect on biochemical characteristics in strawberry fruits.

5.5 Effect of Different Growing Media and Container Size with Respect to Benefit Cost Ratio

The significant differences were observed with respect to benefit cost ratio in strawberry due to influence of various media combination and size of container. The soilless treatment C₁T₃ gave highest (1:1.70) benefit cost ratio while lowest (1:0.40) benefit cost ratio was reported in C₄T₅. It is clear that root trainer tray results is less productivity due to per cent of mortality due to competition between plants for components essential for growth (Prasad, 2017). In addition, the total cost of cultivation and the market price for the produce plays a vital role on the net returns.

CHAPTER-6

SUMMARY AND CONCLUSION

The present investigation entitled “**Effect of container size and growing media on growth, yield and quality of strawberry (*Fragaria × ananassa* Duch.)**” was carried out at Division of Fruit Science, SKUAST-Jammu (J&K) during 2020-21. The results obtained during the course of investigation are summarized below:

6.1 Effect of container size and growing media on growth parameters of strawberry

The maximum plant height (23.24 cm), plant spread (33.45 cm), shoot length (18.08 cm), crown diameter (20.63 mm), number of runners per plant (41.50), runner length (57.51 cm), fresh weight of shoot (7.25 g), shoot dry weight (1.66 g), number of leaves per plant (24.33), leaf area (137.11 cm²), petiole length (10.46 cm) fresh weight of leaves (2.77 g), dry weight of leaves (1.58 g), leaf chlorophyll content (43.28 %), root fresh weight (9.29 g), length of primary roots (19.48 cm) and length of secondary roots (4.71 cm), was obtained in C₂T₃ whereas, the minimum plant height (13.14 cm), plant spread (21.94 cm), shoot length (11.09 cm), crown diameter (13.53 mm), number of runners per plant (16.00), runner length (41.63 cm), fresh weight of shoot (4.11 g), shoot dry weight (0.60 g), number of leaves per plant (6.33), leaf area (110.86 cm²), petiole length (7.14 cm) fresh weight of leaves (1.07 g), dry weight of leaves (0.66 g), leaf chlorophyll content (30.96 %), root fresh weight (6.26 g), length of primary roots (12.98 cm) and length of secondary roots (2.66 cm), was found in C₄T₇. However, the maximum dry weight of root (6.63 g) was obtained in C₅T₃ whereas, the minimum dry weight of root was found in C₄T₇ (2.20 g).

6.2 Effect of container size and growing media on flowering parameters of strawberry

The minimum days taken to initiate first flower (70.66) was produced by C₆T₃ whereas, the maximum days taken to initiate first flower was noted in C₄T₇ (121.66). However, the maximum duration of flowering (67.66 days) was found in C₂T₃ On the

contrary minimum duration of flowering (41.50 days) was observed in C₄T₇. On the other hand, the highest number of flowers per plant (35.66) was observed in C₆T₃, and lowest number of flowers per plant (10.50) was observed in C₄T₇.

6.3 Effect of container size and growing media on fruiting parameters of strawberry

The maximum number of berries per plant (33.00) was produced by C₆T₃, whereas, the minimum number of berries per plant was noted in C₄T₇ (7.00). The maximum berry weight (20.25g) was observed in C₂T₁ while, the minimum berry weight was reported in C₄T₇ (9.97 g). Maximum berry breadth (4.27 cm) was observed in C₂T₁ whereas, the minimum berry breadth was observed in C₄T₇ (2.29 cm). The maximum berry length (4.91 cm) was observed in C₆T₃ and minimum berry length (3.03 cm) was observed in C₄T₇. The highest yield per plant (464.30 g) was observed in C₆T₃ and lowest yield per plant (132.58 g) was observed in C₄T₇.

6.4 Effect of container size and growing media on biochemical parameters of strawberry

The maximum pH (3.48) was found in C₂T₃. On the contrary minimum (2.13) was observed in C₄T₇. The maximum TSS (10.16°Brix) was produced by C₆T₅ whereas, the minimum TSS was noted in C₄T₇ (6.03 °Brix). The maximum TSS: acid ratio (14.01) was observed in C₆T₁ and minimum TSS: Acid ratio (11.97) was observed in C₄T₇. Maximum total sugars (7.53 %) was observed in C₂T₃ whereas, the minimum total sugars was reported in C₄T₇ (4.95 %). The maximum reducing sugars (5.86 %) was obtained in C₆T₃ whereas, the minimum reducing sugars was found in C₄T₇ (4.10 %). The maximum non-reducing sugars (3.63 %) was found in C₂T₃. On the contrary minimum non-reducing sugars (1.10 %) was observed in C₄T₇. The maximum ascorbic acid (54.68 mg per 100 g of fruit) was observed in C₂T₃, followed by C₅T₃ and minimum ascorbic acid (23.97 mg per 100 g of fruit) was observed in C₄T₇.

6.5 Economic Analysis

The net returns from strawberry plants planted in polyethylene bags was found to be maximum in case of T₃ (₹169.16) with B:C ratio of 1:1.66 , followed by T₂ (₹165.94)

with B:C ratio of 1:1.70 and minimum was noted in T₅ (₹25.16) with B:C ratio of 1:1.10. In case of PVC pot, the net returns were noted to be maximum in case of T₃ (₹248.06) with B:C ratio of 1:1.56 , followed by T₂ (₹227.44) with B:C ratio of 1:1.52 and minimum was noted in T₅ (₹74.22) with B:C ratio of 1:0.78. The strawberry plant planted in plastic basket gave maximum net return with benefit cost ratio was found in of T₃ (₹212.20) with B:C ratio of 1:1.66 , followed by T₂ (₹194.16) with B:C ratio of 1:1.62 and minimum was noted in T₅ (₹3.68) with B:C ratio of 1:1.01. The strawberry plants planted in plastic tray, the net returns were noted to be maximum in case of T₇ (₹65.96) with B:C ratio of 1:0.80 , followed by T₂ (₹45.99) with B:C ratio of 1:1.09 and minimum was noted in T₅ which gave negative returns . The net returns in case of earthen pot was found to be maximum in T₂ (₹277.36) with B:C ratio of 1:1.66 , followed by T₁ (₹272.08) with B:C ratio of 1:1.68 and minimum was noted in T₇ (₹125.79) with B:C ratio of 1:1.45. However, in case of root trainer tray, the net returns were found to be negative in all treatments.

6.6 Conclusion

On the basis of study, it can be concluded that soilless cultivation of strawberry can be undertaken as commercial cultivation by utilizing PVC container filled with cocopeat, perlite, and vermicompost media in ratio 3:1:1 as they resulted in better for growth, yield and quality of strawberry cv. Chandler.

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Appendix 1: Cost of inputs purchased for soilless strawberry cultivation cv. Chandler

Item	Cost per unit (in Rupees)
A. Planting material	₹2.00
B. Container	
a. Polyethylene bag	₹ 1.00
b. PVC pot	₹ 30.00
c. Plastic basket	₹16.00
d. Root trainer tray	₹ 70.00
e. Plastic tray	₹ 40.00
f. Earthen pot	₹ 35.00
C. Media	
a. Cocopeat	₹ 36.00
b. Perlite	₹ 38.00
c. Vermicompost	₹ 7.40
d. Farm yard manure	₹ 1.50
D. Container preparation and filling	
a. Labour per man day	₹ 250.00

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CERTIFICATE- IV

Certified that all necessary corrections as suggested by the External examiner and advisory committee have been duly incorporated in the thesis entitled “**Effect of container size and growing media on growth, yield and quality of strawberry (*Fragaria × ananassa* Duch.)**”, submitted by **Ms. Reetika Sharma**, Registration No. **J-19-M-656**.



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