Effect of container types and potting media on the biometric, phenological and yield parameters of strawberry *cv.* Winter Dawn

ABSTRACT

The study was carried out to investigate the growth and yield of strawberry as effected by the container types and potting media. The experiment was conducted at the experimental field, Department of Horticulture, Naini Agricultural Institute, Sam Higginbottom University of Agriculture, Technology and Sciences, Prayagraj (U.P.) during 2022-2024. Three replicates of each plant were tested using three types of containers i.e. Earthen Pot, PVC pot and Thermoform Pot in factorial Completely Randomized Block design. The strawberry plants were planted in containers filled with a growing media of cocopeat, perlite, vermicompost in the following ratios: 1:1:2, 1:2:1, 2:1:1 and Soil, Sand, FYM in the ratio of 1:1:1. Observations on biometric, phenological and yield parameter of each plant were recorded during the study. The result of the statistical analysis revealed that among all the combinations of potting media, the combination of cocopeat, perlite and Vermicompost in the ratio of 1:1:2 was found superior. Better biometric, phenological and yield parameters was observed in plants grown in earthen pots. Based on the interaction effect, plants raised in PVC pots with a growing media ratio of 1:1:2 cocopeat + Perlite + Vermicompost (C2M1) had significantly superior height, growth, flowering and fruiting characters. Thus, strawberry production in open areas, using cocopeat + Perlite + Vermicompost in 1:1:2 ratio in PVC Pots will ensure greater success in plant establishment and produce healthy and disease-free strawberries.

Key word: Strawberry; Perlite; Cocopeat; Vermicompost; FYM; Container; biometric; phenological; yield.

INTRODUCTION

Strawberry (*Fragaria* × *ananassa* Duch.) are classified as stoloniferous, perennial, and short-day forb which grows predominantly in the temperate climate and belongs to the family Rosaceae. Temperatures of (22°C to 25°C) during the day and (7°C to 13°C) at night are suitable for its successful growth (De and Bhattacharjee, 2012). The cultivated strawberry, with its diploid chromosome number of 2n=56 having a basic chromosome number of x=7, is a hybrid between two octoploid species, *Fragaria chiloensis* Duch. and *Fragaria virginiana* Duch. (Bowling, 2000). According to botanical theory, the strawberry is non-climacteric fruit that ripens solely on the plant. It is an aggregate fruit with soft texture having seeds on the surface of the red fleshy receptacle called achenes (Darnell, 2003; Lakshmikanth *et al*., 2020). Strawberry is commercially propagated by runners (Finn and Strik,2008). Its fruit contain 95 % of water and 5 % of dry matter. It is also a rich source of vitamins and minerals with tasty and delicious flavor constituting vitamin-C (94 mg/150 g), vitamin-A (45 IU/150 g) and proteins (1.0 g/150 g). It also contains higher amounts of other components like flavonoids and phenolics.

Strawberry is known for its pleasant aroma and its fruit is used in various commercial food product industries because of its flavor, sugars, lipids content, minerals, natural source of antioxidants, and high fiber content.

Soilless cultivation is an artificial means of providing plants with support and a reservoir for nutrients and water (Raja *et al*., 2018).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 thereby resulting in good vegetative growth characteristics, number of fruits and yield of better-quality strawberries (Adak and Gubbuk, 2015; Shylla *et al*., 2018). Cocopeat is commonly used substrate in India and have high water holding and cation exchange capacity, whereas, perlite provides the required porosity to the media. Vermicompost contains accessible forms of nutrients, in addition to micronutrients elements such as nitrogen, exchangeable phosphorus, potassium, calcium, and magnesium is also present (Edwards and Burrows, 1988). Application of vermicompost in soilless culture boosted strawberry growth and yields (Arancon *et al*., 2004). According to Lakshmikanth *et al*. (2020), the pot culture with various media combinations produces the ideal growing circumstances with an adequate supply of water, macronutrients, micronutrients, and other necessary hormones. 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 as well as the nutritional security for people living in urban and peri-urban areas (Sharma *et al*., 2022).

MATERIALS AND METHODS

The present investigation entitled “Effect of container types and potting media on the biometric, phenological and yield parameters of strawberry *cv.* Winter Dawn” was conducted at the experimental field, Department of Horticulture, Naini Agricultural Institute, Sam Higginbottom University of Agriculture, Technology and Sciences, Prayagraj (U.P.) during 2022-2024. The aim of the experiment was to determine the effect of container types and potting media on growth and yield of strawberry. The experiment was laid out according to completely randomized block design with two factors *viz*. media and container types, each combination replicated thrice with three plants in each replication. Factor 1 consists of different potting media i.e. cocopeat, perlite and vermicompost in ratio of 1:1:2, 1:2:1, 2:1:1 and soil, sand and FYM in ratio of 1:1:1 and Factor 2consist of three types of containers i.e. Earthen Pot, PVC Pot and Thermoform Pot. The details of differences potting media and containers used along with the specific notation are given in Table 1. The plants of strawberry cultivar Winter Dawn were planted under natural light condition at evening during the last week of October. Holes were made at the bottom of each container to allow the drainage of excess water. The prepared mixture of various potting media was filled in containers and kept in open field conditions. Before planting, half of the containers were filled with mixtures, and the other half were filled after the strawberry plant was placed in the middle. The plants were then watered right away until water emerged from the drainage holes. During the first phases, the plants were irrigated every one to two days. Later, mild irrigation was used to keep the potting media moist. All plants were given uniform cultural practices during the course of investigation.

Table 1: Details of different potting media and container types used in the experiment

SL. No	Media Code	Media used	Ratio	Container Code	Container Types
1	M1	Cocopeat + Perlite + Vermicompost	1:1:2	C1	Earthen Pots
2	M2	Cocopeat + Perlite + Vermicompost	1:2:1	C2	PVC Pots
3	M3	Cocopeat + Perlite + Vermicompost	2:1:1	C3	Thermoform Pots
4	M4	Sand + Soil + FYM	1:1:1		

METHODOLOGY AND OBSERVATIONS RECORDED

The various growth, phenological and yield parameter of strawberry plants such as plant height, plant spread, number of leaves per plant, days taken to first flower, flower to harvest duration, days taken to first fruiting, number of fruits per plant, and total yield per plant, were measured in this experiment (Plate 1,2). With the help of a measuring scale, the plant height, plant spread, were measured. The number of leaves and fruits were counted at the end of the growing season and an average number was worked out. The number of days taken to flower from the date of planting was measured, and the mean number of days required to first flower was worked out. The overall significance of the difference among the treatments was tested, using critical differences (C.D.) at a 5% level of significance. The results were statistically analyzed with the help of a windows -based computer package OPSTAT (Sheoran,2004).

Plate 1: Crop at reproductive Stage

Plate 2: Crop at fruit bearing Stage

RESULT AND DISCUSSION

Effect of potting media and container types on biometric parameters: The results of the statistical analysis of the data recorded on growth parameters are shown in Table 2 and Table 3. It has been discovered that there is a noticeable interaction effect between the container types and the potting media on the various growth parameters of strawberry plants. As per the developed protocol in the present study, it was found that among difference media used M1: Cocopeat + Perlite+ Vermicompost (1:1:2) resulted in highest plant height of 16.46 cm followed by M2: Cocopeat + Perlite+ Vermicompost (1:2:1) (14.91cm) and the lowest plant height of 14.22 cm was noted in M3: Cocopeat + Perlite+ Vermicompost (2:1:1). Amongst the different containers used, the plants grown in Earthen Pots (C1) had tallest plants (15.80 cm) which was followed by PVC Pots (C2) (15.61 cm) and shortest plant height of 13.74cm was observed in Thermoform Pots (C3). It is evident from the data that, the interaction between potting media and container types resulted in significant effect and reported that the maximum plant height (18.10 cm) was obtained in C2M1: PVC Pot {Cocopeat + Perlite + Vermicompost, (1:1:2)} followed by C1M1: Earthen Pots {Cocopeat + Perlite + Vermicompost, (1:1:2)} of 17.16 cm whereas, the minimum plant height (13.41 cm) was found in C3M4: Thermoform Pot {Soil+ Sand+ FYM (1:1:1}. The increased height of the plants may be attributed to the presence of nutrients and enough pore spaces in perlite and cocopeat, both of which have improved moisture distribution, cation exchange capacity, water retention capacity, and nutrient and water holding capacity (Firoozabadi *et al*., 2009; Por-Hossein *et al*., 2009). 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. According to Tabatabaei *et al.* (2006) media consisted of perlite increased plant height in strawberry. Similar result was reported by Hassan *et al*. (2011) conducted extensive research and found that utilizing coconut husk resulted in the largest plant height in strawberry, whereas soil cultivation produced the lowest. These results were similar with the earlier findings of Tariq *et al*., 2013; Rostami *et al*., 2014; Singh *et al*., 2015; Sharma and Godara 2017; Raja *et al*., 2018; Thakur and Shylla 2018; Kumar *et al*., 2022; Sharma *et al*., 2022.

As evident from Table 2, among the difference media, M1: Cocopeat + Perlite+ Vermicompost (1:1:2) resulted in maximum plant spread of 14.46 cm followed by M2: Cocopeat + Perlite+ Vermicompost (1:2:1) with 12.91 cm and the minimum plant spread of 12.22 cm was noted in M3Cocopeat + Perlite+ Vermicompost (2:1:1). Amongst the different containers used, the plants grown in Earthen Pots (C1) had maximum plants spread of 13.80cm which was followed by PVC Pots (C2) (13.61cm) and minimum plant spread of 11.74cm was observed in Thermoform Pots (C3). It is evident from the data that the interaction effect of C2M1: PVC Pots {Cocopeat + Perlite+ Vermicompost (1:1:2)} resulted in maximum plant spread of 16.10 cm. It was followed by C1M1: Earthen Pots {Cocopeat + Perlite+ Vermicompost (1:1:2)} with a plant spread of 15.17 cm whereas, the minimum plant spread of 11.41 cm was found in C3M4: Thermoform Pots {Soil + Sand +FYM (1:1:1)}. Hesami *et al*. (2012) concluded that the treatment with the combination of soilless substrate i.e. perlite + cocopeat recorded the highest plant spread in strawberry. Lakshmikanth *et al*. (2020) revealed that the treatment with the combination of Soil + cocopeat + vermiculite + vermicompost in 1:1:1:1 ratio gave the highest plant spread of 31.27 cm North-South and 30.21cm East-West direction in strawberry plant. Similar results were reported by Ameri *et al*. (2012), they found that the maximum plant spread was observed in 50% cocopeat + 50% perlite and 5% vermicompost + 45% perlite + 50% cocopeat in strawberry *cv.* Camarosa. Also, these results were in conformity with Sharma *et al.,* 2016; Sharma and Godara 2017 and Sharma *et al.,* 2022.

Table 2: Effect of container types and potting media on plant height and plant spread in strawberry *cv.* Winter Dawn

	Plant Height (cm)					Plant Spread (cm)				
	M1	M2	M3	M4	MEAN	M1	M2	M3	M4	MEAN
C1	17.16	16.63	14.42	15.00	15.80	15.17	14.63	12.42	13.00	13.80
C2	18.10	14.25	14.63	15.47	15.61	16.10	12.25	12.63	13.47	13.61
C3	14.12	13.86	13.60	13.41	13.74	12.12	11.85	11.60	11.41	11.74
Mean	16.46	14.91	14.22	14.62		14.46	12.91	12.22	12.62	
Factor	C.D(5%)	SE(d)	SE(m)	*CV.*		C.D(5%)	SE(d)	SE(m)	*CV.*	
Factor C	0.27	0.13	0.09	0.49		0.32	0.15	0.11	0.57	
Factor M	0.32	0.15	0.11	0.57		0.37	0.18	0.12	0.68	
Factor C x M	0.55	0.26	0.19	0.99		0.63	0.30	0.22	1.14	

C1 - Earthen Pot C2 - PVC Pot C3 – Thermoform Pot

M1-M3 (Cocopeat: Perlite: Vermicompost) M4 (Soil: Sand: FYM)

The highest number of leaves per plant (23.55) was produced by potting media M1: Cocopeat + Perlite+ Vermicompost (1:1:2) followed by M2: Cocopeat + Perlite+ Vermicompost (1:2:1) with 20.23 number of leaves per plant, whereas minimum number of leaves per plant (17.88) was observed in M4: Soil+ Sand + FYM (1:1:1). In case of different containers, maximum number of leaves per plant (22.46) was reported in Earthen pots (C1) followed by PVC Pots (C2) having 22.30 leaves whereas, the minimum number of leaves per plant

(15.12) was found in Thermoform Pots(C4). Also, significant results were obtained as an outcome of the interaction effect of potting media and types of containers. The result of statistical analysis of interaction effect revealed that the maximum number of leaves per plant (26.67)was produced by C2M1: PVC Pots {Cocopeat + Perlite+ Vermicompost (1:1:2)}.It was followed by C1M1: Earthen Pots {Cocopeat + Perlite+ Vermicompost (1:1:2)which had 25.50 leaves per plant whereas, the minimum number of leaves per plant of 10.00 was noted in C3M4: Thermoform Pots {Soil + Sand +FYM (1:1:1)}.Hassan *et al*. (2011) found that utilizing coconut husk resulted in the largest number of leaves in strawberry whereas, soil cultivation produced the lowest. According, to Selda and Anapali, (2010) number of leaves decreased as the soil amount increased in the media. Hesami *et al*. (2012) also reported that the treatment with the combination of soilless substrate i.e. perlite + cocopeat recorded the highest number of leaves. Thakur and Shylla (2018) also concluded that the maximum number of leaves were produced when strawberry *cv.* Chandler was grown under protected conditions and perlite was used as a potting media as compared to control (soil). These results were similar with the earlier findings of Khalid *et al*., 2013; Kumar *et al*., 2014; Singh *et al*., 2015; Sharma *et al.,* 2016; Sharma and Godara 2017; Thakur and Shylla 2018; Raja *et al*., 2018; Lakshmikanth *et al*., 2020 and Sharma *et al*., 2022.

Table 3: Effect of container types and potting media on number of leaves per plant of strawberry *cv.* Winter Dawn

	Number of leaves per plant				
	M1	M2	M3	M4	MEAN
C1	25.50	24.50	19.50	20.33	22.46
C2	26.67	19.20	20.00	23.33	22.30
C3	18.50	17.00	15.00	10.00	15.12
Mean	23.55	20.23	18.17	17.88	
Factor	C.D(5%)	SE(d)	SE(m)	*CV.*	
Factor C	0.35	0.17	0.12	0.65	
Factor M	0.41	0.20	0.14	0.76	
Factor C x M	0.70	0.34	0.24	1.29	

C1 - Earthen Pot C2- PVC Pot C3- Thermoform Pot

M1-M3 (Cocopeat+ Perlite + Vermicompost), M4 (Soil+ Sand+ FYM)

Effect of potting media and container types on phenological parameter: The results of the statistical analysis of various phenological parameter observed in the present experiment is depicted in Table 3 and Table 4. From the data it is evident that among difference media M1: Cocopeat + Perlite+ Vermicompost (1:1:2) took minimum of 52.70 days for first flowering which was followed by M4: Soil + Sand +FYM (1:1:1) which took 56.89 days. The maximum of 58.82 days for first flowering was observed under M3: Cocopeat + Perlite+ Vermicompost (2:1:1). In containers, the minimum of 53.86 days taken to first flower was recorded in earthen pots (C1) followed by PVC pots (C2) which had first flower appearance in 54.37 days. The maximum days of 61.38 taken to initiate first flower was observed in Thermoform Pots (C3). From the interaction, the minimum days taken to initiate first flower (47.10) was recorded in C2M1: PVC Pots {Cocopeat + Perlite+

Vermicompost (1:1:2)} which was followed by C1M1: Earthen Pots {Cocopeat + Perlite+ Vermicompost (1:1:2)} with 49.34 days whereas, the maximum days taken to initiate first flower (62.17) was noted in C3M4: Thermoform Pots {Soil + Sand +FYM (1:1:1)}.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 potting 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). Sharma and Godara (2017) reported that the strawberry plants grown in earthen pots produced earliest flowering of 78.97 days and 79.53 days. These results were similar to Tariq *et al*. (2013) and Sharma *et al*. (2022).

The data as shown in Table 4 revealed that the potting media M1: Cocopeat+ Perlite+ Vermicompost (1:1:2) resulted in minimum days (29.03) from the emergence of flower to the day of harvest followed by M2: Cocopeat + Perlite + Vermicompost (1:2:1) which took 32.09 days from flower emergence to harvest. The maximum of 34.27 days was observed in M4: Soil + Sand + FYM (1:1:1). Amongst the different containers used, the plants grown in PVC Pots (C2) had minimum days of 31.29 from flowering to harvest followed by Earthen pots (C1) which took 32.27 days and maximum days of 32.89 was observed in Thermoform Pots (C3). It is evident from the data that the interaction between potting media and container types resulted in significant effect on flowering to harvest duration. It was reported that the minimum days of 27.67 was obtained by C2M1: PVC Pot {Cocopeat + Perlite+ Vermicompost, (1:1:2)} which was followed by C1M1: Earthen Pot {Cocopeat + Perlite + Vermicompost, (1:1:2)} with 28.75 days. Maximum days (35.56) was found in C3M4 in the interaction between thermoform pot using Soil+ Sand + FYM (1:1:1) as the media. Albaho *et al*. (2008) reported that flowers in soilless media blossomed earlier than those in soil-based growth systems. According to Prasad (2017) bud dormancy is broken and flowering is enhanced when vermicompost and perlite are combined. These earlier reports are in conformity with the present findings. The present results were also similar to the findings by Ayesha *et al*., 2011; Hesami *et al*., 2012; Khalid *et al*., 2013; Sharma *et al.,* 2016 and Sharma *et al*., 2022. Therefore, growing strawberry in PVC Pot using Cocopeat + Perlite+ Vermicompost in 1:1:2 ratio provides the perfect growing conditions that can shorten the strawberry crop's blossom to harvest time, making the production cycle faster and more effective.

As seen from Table 4, the results of statistical analysis for days for first fruiting shows significant difference among the various media combination employed in the present experiment. It was recorded from the data that potting media M1: Cocopeat + Perlite + Vermicompost (1:1:2) resulted in minimum days (72.53) taken from the day of planting to the day of first appearance of the fruit followed by M2: Cocopeat + Perlite + Vermicompost (1:2:1) (78.05 days) and the maximum days (79.31) was observed in M3: Cocopeat + Perlite + Vermicompost (2:1:1).

The results of statistical analysis as shown in Table 4, exhibited significant difference among the various container types analyzed for days to first fruiting. Amongst the different containers used, the plants grown in Earthen Pots (C1) had minimum days of 74.36 for first fruiting followed by PVC pots (C2) which had first fruiting in 75.02 days and maximum days (81.83) was observed in Thermoform Pots (C3). It is evident from the data that the interaction between potting media and container types resulted that the minimum days

(68.13) was obtained by C2M1: PVC Pot {Cocopeat + Perlite + Vermicompost, (1:1:2)} which was followed by C1M1 (69.07). The maximum days (83.61) for first fruiting was found in C3M4: Thermoform Pots {Soil+ Sand + FYM (1:1:1)}. Growing strawberry using cocopeat keeps the soil at the ideal moisture content, which encourages quick root development and early flowering. Perlite guarantees that the roots receive enough oxygen, which promotes strong development and early fruiting. Vermicompost adds vital nutrients to the soil, which speeds up plant growth and encourages fruit and flowering. When combined, these elements produce a growing environment that is conducive to strawberries reaching maturity more quickly, which shortens the time taken for potted strawberry plants to reach the harvesting stage. These results were analogous with the earlier findings of Ayesha *et al.,* 2011; Hesami *et al*., 2012; Khalid *et al*., 2013 and Sharma *et al*., 2022.

Table 4: Effect of container types and potting media on days to first flowering of strawberry *cv.* Winter Dawn

	Day to first flowering				
	M1	M2	M3	M4	MEAN
C1	49.34	53.39	58.06	54.67	53.86
C2	47.10	59.00	56.67	53.83	54.37
C3	60.78	60.83	61.74	62.17	61.38
Mean	52.70	57.74	58.82	56.89	
Factor	C.D(5%)	SE(d)	SE(m)	*CV.*	
Factor C	0.64	0.31	0.22	1.78	
Factor M	0.74	0.36	0.25	1.37	
Factor C x M	1.28	0.62	0.44	2.36	

C1 - Earthen Pot C2- PVC Pot C3- Thermoform Pot

M1-M3 (Cocopeat+ Perlite + Vermicompost), M4 (Soil+ Sand+ FYM)

Table 5: Effect of container types and Potting media on flower to harvest duration and days taken to first fruiting on strawberry *cv.* Winter Dawn

	Flower to harvest duration					Days taken to first fruiting				
	M1	M2	M3	M4	MEAN	M1	M2	M3	M4	MEAN
C1	28.75	34.51	32.33	33.50	32.27	69.07	73.50	78.11	76.78	74.36
C2	27.67	31.17	32.58	33.75	31.29	68.13	79.39	77.78	74.78	75.02
C3	30.68	30.58	34.75	35.56	32.89	80.39	81.28	82.05	83.61	81.83
Mean	29.03	32.09	33.22	34.27		72.53	78.05	79.31	78.39	
Factor	C.D(5%)	SE(d)	SE(m)	*CV.*		C.D(5%)	SE(d)	SE(m)	*CV.*	
Factor C	0.47	0.23	0.16	0.87		0.55	0.26	0.19	0.99	
Factor M	0.54	0.26	0.19	0.99		0.63	0.30	0.22	1.14	
Factor C x M	0.94	0.45	0.32	1.71		1.09	0.53	0.37	2.01	

C1 - Earthen Pot	C2 - PVC Pot	C3 - Thermoform Pot
M1-M3 (Cocopeat+ Perlite + Vermicompost)		M4 (Soil + Sand+ FYM)

Effect of container types and potting media on yield parameter: The result of the statistical analysis of yield parameter are shown in Table 5 and depicted graphically in Fig 1. It was found that among difference combination of potting media used M1: Cocopeat + Perlite + Vermicompost (1:1:2) resulted in maximum number of fruits per plant (13.78) followed by M2: Cocopeat + Perlite + Vermicompost (1:2:1) which had 11.70 fruits per plant. The minimum number of fruits per plant (10.82) was observed in M3 which consist of Cocopeat + Perlite + Vermicompost in the ratio 2:1:1. Amongst the different containers used, the plants grown in Earthen pots (C1) had maximum number of fruits per plant of 13.56 followed by PVC pots (C2) which had 13.48 fruits per plant. The minimum number of fruits per plant (8.78) was observed in Thermoform Pots (C3).

It is evident from the data that the interaction between potting media and container types resulted in significant difference for number of fruits per plant. The maximum number of fruits per plant (15.91) was obtained in C2M1 in which strawberry plant were grown in PVC Pots with potting media of Cocopeat +Perlite + Vermicompost in the ratio of 1:1:2 which was found to be at par with C1M1 which had 15.33number of fruits per plant. The minimum number of fruits per plant (7.08) was found in C3M4: Thermoform Pots {Soil+ Sand + FYM (1:1:1)}.

It is evident from the data that the maximum yield of 305.82 g per plant was observed under M1: Cocopeat + Perlite + Vermicompost (1:1:2) followed by M2: Cocopeat + Perlite + Vermicompost (1:2:1) which had 268.12g per plant. However, the minimum yield per plant (254.86g) was recorded under M3: Cocopeat + Perlite + Vermicompost (2:1:1). The earthen pot (C1) produced maximum yield per plant (306.93g), followed by PVC pots (C2) which had a yield of 300.69 g per plant. The minimum yield per plant (210.90 g) was observed in Thermoform Pots (C3). Further, the interaction between the potting media and container types were found significant and data revealed that the maximum yield per plant (341.00g) was recorded in C2M1: PVC Pots {Cocopeat + Perlite + Vermicompost (1:1:2)} which is at par with C1M1: Earthen Pots {Cocopeat + Perlite + Vermicompost (1:1:2)} with a yield of 331.10g per plant. The minimum yield per plant (183.78 g) was observed in C3M4 where strawberry plant grown in Thermoform Pots with a potting media of Soil+ Sand + FYM in the ratio of 1:1:1. Similar result was reported by Hesami *et al*. (2012) that the yield of strawberry significantly varied by soilless potting media composed of different ratios of cocopeat, perlite, pumice, vermicompost, sawdust, and zeolite. 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). Maher *et al*. (2020) revealed that perlite (75 %) + cocopeat (25 %) + jeevambrit resulted in the maximum fruit yield per plant of 210.09 g. These results were similar to Khalid *et al*., 2013; Rostami *et al*., 2014; Godara and Sharma 2016; Thakur *et al*., 2018; Lakshmikanth *et al*., 2020 and Sharma *et al*., 2022.

Table 6: Effect of Container types and potting media on number of fruits per plant and total yield per plant of Strawberry *cv.* Winter Dawn

	Number of fruits per plant					Total yield per plant (g)				
	M1	M2	M3	M4	MEAN	M1	M2	M3	M4	MEAN
C1	15.33	14.25	11.58	13.07	13.56	331.10	319.63	274.17	301.91	306.93
C2	15.91	11.34	12.43	14.25	13.48	341.00	259.72	300.07	301.95	300.69
C3	10.09	9.50	8.45	7.08	8.78	244.47	225.02	190.33	183.78	210.90
Mean	13.78	11.70	10.82	11.46		305.82	268.12	254.86	262.54	
Factor	C.D(5%)	SE(d)	SE(m)	*CV.*		C.D(5%)	SE(d)	SE(m)	*CV.*	
Factor C	0.44	0.21	0.15	0.80		13.61	6.56	4.64	24.93	
Factor M	0.50	0.24	0.17	0.91		15.72	7.57	5.35	28.77	
Factor C x M	0.87	0.42	0.30	1.60		27.22	13.11	9.27	49.82	

C1 – Earthen Pot C2- PVC Pot C3- Thermoform Pot

M1-M3 (Cocopeat+ Perlite+ Vermicompost) M4 (Soil + Sand + FYM)

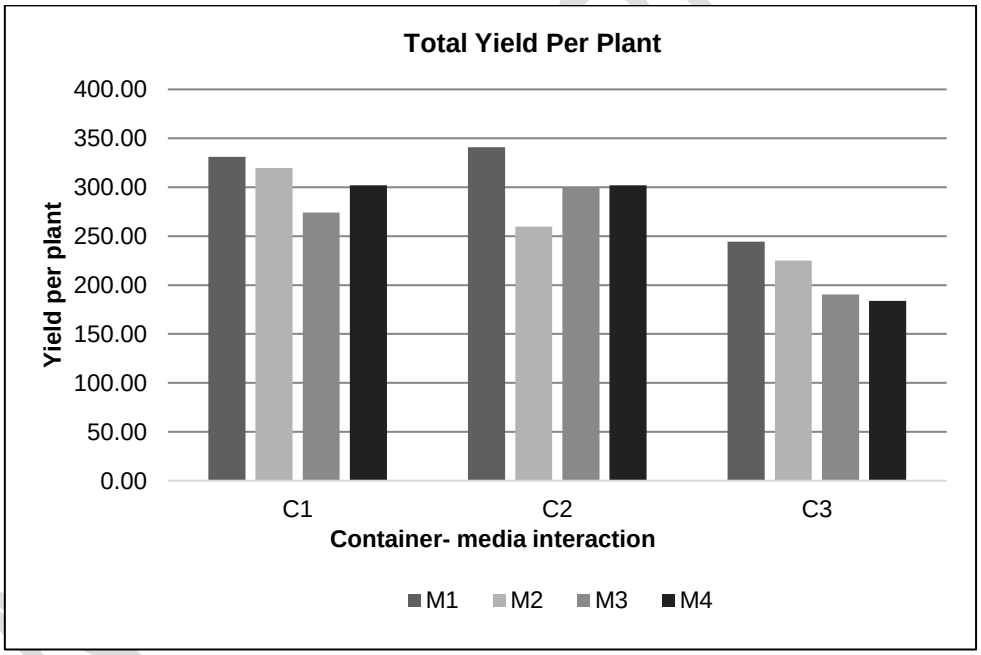

Fig 1: Total Yield per plant

Manole *et al.* (2008) had also reported the significant influence of container type on the substrate biological activity and growth parameters of plants. In the present study, among the containers, plants grown in earthen pots were superior in growth and yield characters and less growth was recorded in Thermoform pots. This might be due to the natural cooling effect attributed to the porous nature of clay. Godara and Sharma (2016) also reported that from different containers used, the maximum growth parameter was in earthen pots followed by PVC pots.

From the interaction between the potting media and the container types the plants grown in PVC pots in Cocopeat+ Perlite+ Vermicompost in the ratio of 1:1:2 significantly increased all the biometric observations

recorded like the plant height, plant spread, number of leaves, etc. The enhanced vegetative growth might have contributed to the superior yield in strawberry plants grown in PVC pots using Cocopeat+ Perlite+ Vermicompost in the ratio of 1:1:2. Similar finding was reported by Sharma *et al.* (2017). He found that the plant grown in PVC pots with combination of potting media (cocopeat + perlite + vermicompost, 3:1:1) had superior growth parameters like maximum number of leaves (10.45 and 15.42), plant spread (27.43 cm and 30.24 cm) and crown diameter (17.44 mm and 18.10 mm). Sharma and Godara (2017) also concluded that strawberry show best performance when grown in PVC pots. The higher temperature of rooting media resulted better root and shoot growth of the plant in the winter season which might be due to the elevated temperature of the rooting media in PVC pots due to absence of evaporative cooling, which is related to the findings in this research. Similar results were obtained by Sharma *et al.* (2022). They revealed that from among all the treatments the plant raised in PVC pots with a potting media ratio of 3:1:1 Cocopeat, Perlite and Vermicompost had significantly higher height, higher growth, maximum flowering and fruiting characters.

CONCLUSION

Growing strawberries in pots or growbags filled with potting substrate is an easy way to meet the year-round demand for strawberries and to ensure the nutritional security of people living in urban and peri-urban areas. As per the present investigation, the combination of potting media using cocopeat, perlite, Vermicompost in the ratio of 1:1:2 was found superior among all other combination studied. Among the different containers evaluated the performance of strawberry plants grown in earthen pots showed enhanced biometric, phenological and yield characters. The findings of the study enable us to conclude that the potting media and container types directly influence the growth and yield of strawberry *cv.* Winter Dawn. Therefore, cultivating strawberry by utilizing PVC pots filled with cocopeat, perlite, and vermicompost media in a ratio of 1:1:2 can increase the overall production of strawberry by utilizing the unallocated spaces (like balconies, rooftops etc.). This experiment can also be an effective method in the production of disease- free strawberries and to augment the farmer's income.

REFERENCE

1. Adak N, and Gubbuk H. Effect of planting systems and potting media on earliness, yield and quality of strawberry cultivation under soilless culture. Notulae Botanicae Horti Agrobotanici Cluj-Napoca. 2015; 43(1): 204-209.
2. Albaho M, Thomas B, and Christopher A. Evaluation of hydroponic techniques on growth and productivity of greenhouse grown bell pepper and strawberry. International Journal of Vegetable Science. 2008; 14(1): 23-40.
3. Ameri A, Tehranifar A, Shoor M, and Davarynejad GH. Effect of substrate and cultivar on growth characteristic of strawberry in soilless culture system. African Journal of Biotechnology. 2012; 11(56): 11960-11966.
4. Arancon NQ, Edwards CA, Bierman P, Welch C, Metzger JD. Influences of vermin-composts on fields strawberries on growth and yields. Bioresource Technology. 2004; 93, 145-153.

5. Ayesha R, Fatima N, Ruqayya M, Faheem H, Qureshi KM, Hafiz IA, Khan KS, Ali U and Kamal A. Influence of different growth media on the fruit quality and reproductive growth parameters of strawberry (Fragaria × ananassa). Journal of Medicinal Plants Research. 2011; 5(26): 6224-6232.
6. Bowling BL. The Berry Grower‟s Companion. Timber Press Inc., Portland, Oregon, USA. 308p. 2000.
7. Darnell R, Strawberry growth and development. The Strawberry: A Book for Growers and Others, held at Florida, Gainesville, (Childers NF ed). Institute of Food and Agricultural Sciences, University of Florida, Gainesville, USA. 2003
8. De LC and Bhattacharjee SK. Handbook of Edible Fruits. Aavishkar Publishers, Distributors, Jaipur 302003 (Raj.), India, p 312. 2012.
9. Ebrahimi R, Souri MK, Ebrahimi F and Ahmadizadeh M. Growth and yield of strawberries under different potassium concentrations of hydroponic system in three substrates. World Applied Sciences Journal. 2012; 16(10): 1380-1386.
10. Edwards C A and Burrows I. The potential of earthworm composts as plant growth media. In: Edwards, C.A. and E. Neuhauser (Eds.). Earthworms in waste and environmental management. SPB Academic Press. The Hague, the Netherlands. 1988; pp: 21-32.
11. Finn CE and Strik BC. Strawberry cultivars for Oregon., EC 1618-E, Oregon State University. 2008; pp. 1-7.
12. Firoozabadi M, Amrolahi A and Hokmabadi H. Effect of different concentration of nitrogen, calcium, potassium in soilless growing strawberry (*Fragaria selva*). 6th Iranian Congress of Horticultural Science, Guilan, Iran. 2009; pp: 123-124.
13. Godara AK and Sharma VK. Influence of soilless media and containers on shoot growth of strawberry *Fragaria* x *ananassa* Duch *cv.* Sweet Charlie. International Journal of Farm Sciences. 2016; 6(1): 112-119.
14. Godwa BM. Evaluation of different genotypes for growth, yield and quality of strawberry (Fragaria x ananasa Duch.) under naturally ventilated polyhouse in hill zone of Karnataka. M.Sc. Thesis, University of Agricultural and Horticultural Sciences, Shimoga, Karnataka, India. 2016; pp. 46.
15. Hassan AH, Khereba, AH, El-Kattan MH, Noha G and El- Rahman A. Effect of various organic substrate culture and container types on productivity and fruit quality of strawberry (Fragaria × ananassa) *cv.* Festival. Research Journal of Agriculture and Biological Sciences. 2011; 7: 379-387.
16. Hesami A, Khorami SS, Amini F and Kashkooli AB. Date-peat as an alternative in hydroponic strawberry production. African Journal of Agricultural Research. 2012; 7(23): 3452-3458.
17. Khalid S, Qureshi KM, Hafiz IA, Khan KS and Qureshi US. Effect of organic amendments on vegetative growth, fruit and yield quality of strawberry. Pakistan Journal of Agricultural Research. 2013; 26(2): 104-112.
18. Kumar Rakesh, Hansra BS, Dubey Neeru, Kumar Amit and Kumar Pradeep. Potting substrate effect on yield and quality of strawberry (*Fragaria* × *ananassa*) in terrace gardening, Indian Journal of Agricultural Sciences. 2022; 92 (5): 667–9, May 2022.
19. Kumar A, Pandey SD, Rai RR and Vishal N. Evaluation of alternate potting media mixtures for raising quality-planting material of litchi in polybags. The Bioscan. 2014; 9(1): 381-384.

20. Lakshmikanth KH, Madaiah D, Dinesh Kumar M and Dhananjaya BC. Effect of different pot culture media on growth parameters, yield and economics of strawberry in vertical system. International Journal of Chemical Studies. 2020; 8(3): 2122-2125.
21. Maher MM, Shylla Bunty, Sharma DD, Sharma Uday and Kuchay MA. Yield and quality of polyhouse grown strawberries as affected by soilless media and jeevamrit. International Journal of Chemical Studies. 2020; 8(3): 585-589.
22. Manole MS, Rosu M, Dobrin E, Ciofu R and Gheorghita N. The influence of pot type on the biological activity of the substrate and the seedlings growth. AnaleleUniversitatii din Craiova, 2008; 13: 313-320.
23. Odongo T, Isutsa DK and Aguyo JN. Effects of integrated nutrient sources on growth and yield of strawberry grown under tropical high -altitude conditions. African Journal of Horticultural Science, 2008;1: 53-69.
24. Por-Hossein L, Ebadi A and Mostufi Y. Effect of nutrient solutions EC levels and type of media on strawberry growth and yield in hydroponic system. 6th Iranian Congress of Horticultural Science, *Guilan, Iran*. 2009; pp. 1486-1489.
25. Prasad R. Agro-Technique intervention for Strawberry (*Fragaria x ananassa* Duch.) on vertical growing system under naturally ventilated polyhouse. M. Sc. Thesis, University of Agricultural and Horticultural Sciences, Shivamogga, Karnataka, India. 2017.
26. Raja WH, Kumawat KL, Sharma OC, Sharma A, Mir JI, Nabi SU, Lal S and Qureshi I. Effect of different substrates on growth and quality of strawberry *cv.* Chandler in soilless culture. The Pharma Innovation Journal. 2018; 7(12): 449-453.
27. Rostami Z, Ghahsare AM and Kavoosi B. Date palm waste application as culture media for strawberry and its impact on some growth indices and yield components. Agricultural Communications. 2014; 2: 15-21.
28. Selda O, Anapali O. Effect of soil addition on physical properties of perlite -based media and strawberry *cv.* Camarosa plant growth. Scientific Research and Essays. 2010; 5(22), 3430-3433.
29. Sharma Kumar, Vikas Godara and Kumar Anil. Response in Strawberry (*Fragaria* × *ananassa* Duch. 'Sweet Charlie') Growth to Different Substrates and Containers under Greenhouse. International Journal of Current Microbiology and Applied Sciences. 2017; *ISSN: 2319-7706* Volume 6 pp. 2556-2568.
30. Sharma Kumar, Vikas Godara and Kumar Anil. Effect of substrate mixtures on precocity and flower development in strawberry potted plants. Journal of Pharmacognosy and Phytochemistry, 2017; 6(5): 2406-2412.
31. Sharma Reetika, Bakshi Prashant, Kour Kiran, Jasrotia Amit, Kumar Rakesh, Maanik Abrol, Vikas Lal, Manmohan Singh, Gurwinder Rana, Kanchan and Sharma Sakshi. Effect of container size and potting media on growth, yield and quality of strawberry (*Fragaria* × *ananassa* Duch.). Agricultural Mechanization in Asia. 2022; *ISSN*: 00845841 Volume 53.
32. Sheoran OP. Statistical package for Agricultural Research workers, CCS HAU, Hisar. http://hau.ernet.in. 2004.
33. Singh AK, Karma B and Pal AK. Effect of vermicompost and biofertilizers on strawberry growth, flowering and yield. Annals of Plant and Soil Research, 2015; 2:196-199.

34. Tabatabaei SJ, Fatemi LS, Fallahi E. Effect of ammonium, nitrate ratio on yield, calcium concentration and photosynthesis rate in strawberry. Journal of Plant Nutrition. 2006; 29, 1273-1285.

35. Tariq R, Qureshi KM, Hassan I, Rasheed M and Qureshi US. Effect of planting density and potting media on growth and yield of strawberry. Pakistan Journal of Agricultural Research. 2013; 26(2): 113-123.

36. Tehranifar A, Poostchi M, Arooei H and Nematti H. Effects of seven substrates on qualitative and quantitative characteristics of three strawberry cultivars under soilless culture. Acta Horticulturae. 2007; 761: 485-488.

37. Thakur B and Shylla B. Influence of different potting media on plant growth and fruit yield of strawberry (*Fragaria* × *Ananassa* Duch.) *cv.* Chandler grown under protected conditions. International Journal of Current Microbiology Applied Sciences. 2018; 7(4): 2724-2730.