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Influence of Different Growing Media on Plant Growth and Fruit Yield of Strawberry (*Fragaria* × *Ananassa* Duch.) Cv. Chandler Grown under Protected Conditions

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A B S T R A C T

Effect of different growing media on plant growth and fruit yield of strawberry (*Fragaria* × *ananassa* Duch.) cv. Chandler under protected conditions were conducted during the cropping seasons of 2015-16 and 2016-17. The studies concluded that perlite + FYM (1:1) media was most effective in improving plant growth and yield parameters than all other treatments. The studies have also revealed that perlite as a growing media was very effective in improving plant growth parameters even when it was used alone as indicated by various growth parameters such as number of leaves, root length and number of runners. The studies have conclusively proved perlite in combination with FYM to be an effective media that can be successfully used for producing elite planting material of strawberry under polyhouse.

Introduction

Strawberry (*Fragaria* × *ananassa* Duch.), a member of the family Rosaceae, is a soft fruited, short-day herbaceous perennial plant that can successfully be grown at optimum day temperatures of 22°C to 25°C and night temperatures of 7°C to 13°C (De and Bhattacharjee, 2012). Commercially grown strawberry (*Fragaria* x *ananassa* Duch.) is a monoecious octoploid (2n=56) hybrid of two dioecious octoploid species, namely, *Fragaria chiloensis* Duch. and *Fragaria virginiana* Duch. (Bowling 2000) with a basic chromosome number (x) of 7. Botanically, strawberry is an aggregate fruit having seeds on the surface of a red fleshy receptacle (Darnell, 2003).

The last decade has witnessed the emergence of strawberry as the leading fruit in the category of soft berries. The area and production under strawberry in the world has increased logarithmically during the last two decades as much of the crop is being grown under protected structures. In India, strawberry is cultivated on a commercial scale in the states of Maharashtra, Punjab, Haryana, Delhi, parts of Himachal Pradesh, Jammu & Kashmir, Uttrakhand, Uttar Pradesh, West

Bengal (Darjeeling hills) and Rajasthan (Rana and Chandel, 2003). Strawberry cultivation In Himachal Pradesh is in its infancy and has gained momentum in the recent past.

The major drawback however lies with the non-availability of good and healthy planting material owing to soil borne pathogens, nematodes and the soil conditions. Soil-borne pathogens are often associated with severe production losses in strawberry culture. To eliminate soil borne diseases and pests, the use of soilless growing media is therefore of utmost importance and is gaining popularity.

A wide variety of soilless media are currently in use in different parts of the world to act as suitable substitutes for soil (De-Rijck and Schrevens, 1998). Out of these growing media, the most commonly used soilless growing media for strawberries are peat moss, rockwool, perlite and cocopeat. The properties of the constituents of different growing media are known to have direct and indirect effects on plant growth and productivity. Among all properties of growing media, pore space, water holding capacity, bulk density, pH, soluble salt content and distribution of the particles size are important physical and chemical properties.

Materials and Methods

The present investigation was cvonducted at the Horticultural Research & Training Station and Krishi Vigyan Kendra (HRTS and KVK) Kandaghat, Solan in Himachal Pradesh during the cropping seasons of 2015-16 and 2016-17 using Completely Randomized Block Design (CRBD) for statistical analysis of the results obtained during the courase of studies. The experiment had six treatments, each with four replications consisting 24 beds (1x1 m) in which strawberry cultivar 'Chandler' runners were planted at a spacing of 20x 20 cm during October, 2015 and 2016.

The beds were filled with different media according to the treatments (T_1-T_6) and subsequently lined with black polythene sheet upto twelve inches. The plants were irrigated at 1-2 days interval through microsprinkler irrigation during the initial stages and later by using drip irrigation during fruiting stage while recommended dose of fertilizers were applied through fertigation using soluble fertilizers (19:19:19). All plants were subjected to uniform cultural practices during the course of investigations. Ten plants per treatment were randomly marked for recording the observations.

The effects of growing media were observed by determining plant height (cm), leaf area (cm^2), number of leaves, number of crowns, root length (cm), number of runners and length of runners (cm) while effects on yield were evaluated by determining yield per plant (g) and yield per hectare (t/ha). The plant height (cm), number of leaves per plant, number of crowns per plant, root length, number of runners per plant, length of runners, number of flowers, per cent berry set and yield per plant (g) were recorded as per standard practices. The leaf area was measured by leaf area meter (Licor-Model 3100) and expressed in square centimeter (cm^2). Statistical analysis of the data was carried out by the method suggested by Panse and Sukhatme by using MS-Excel and OPSTAT (Sheoran *et al.,* 1998).

Results and Discussion

Effect of growing media on plant growth

The data pertaining to the growth characteristics presented in Table 1 indicated that perlite in combination with FYM significantly influenced the vegetative growth parameters particularly plant height, number of leaves and leaf area during both the years of investigation. A critical look at the pooled data

revealed that the maximum plant height (29.19 cm), number of leaves (18.31) and leaf area (135.08 cm^2) were observed under perlite + FYM (T_2) treatment and the minimum plant height (25.28 cm), number of leaves (14.70) and leaf area (120.74 cm^2) were recorded under soil + FYM (T_6) treatment. Similar results were obtained on the effect of different growing media in case of leaf area and number of crowns. Additionally, on the basis of statistical analysis of the data presented in Table 2, it was observed that different growing media had no significant effect on the number of crowns.

The maximum enhancement in plant growth under T_2 treatment could be attributed to better water holding capacity and nutrient availability which in turn promotes better vegetative growth (Beardsell *et al.,* 1979, Anagnostou and Vassilakakis 1995 and Chhukit 2009). These observations are in conformity with the findings of Verdonck *et al.,* (1981) and Traka-Mavrona *et al.,* (2001) who also observed better growth performances when perlite-based mixtures were used. Perlite alone has also been reported) to have excellent growth performance when used as a substrate in hydroponic culture (Hall *et al.,* 1988).

The runner production and root length were significantly influenced by different growing media treatments which is evident from the data set out in Table 3. A perusal of pooled data reveals that the maximum root length (19.16) was recorded under perlite + FYM (T_2) treatment which was however statistically at par with all other treatments except for the control (T_6) treatment. Maximum number of runners (40.00) was produced under perlite + FYM (T_2) treatment which was statistically at par with perlite treatment whereas the least number of runners were observed under the control (T_6) treatment.

These findings go in line with the observations made by Joshi (2003) who also reported that perlite when used in combination as a growing media resulted in better aeration and good nutrient supply. This ultimately results in more runner production and subsequently more plantlets per runner.

Studies conducted by various workers have indicated at perlite and its combination mixture being a substrate with excellent features capable of improving growth and development of plants grown in soilless cultivation owing to its high water retention capacity which increases water efficiency (Djedidi *et al.,* 1999 and Inden and Torres 2004). Various workers (Bartczak *et al.,* 2007, Albaho *et al.,* 2009, Ayesha *et al.,* 2011 and Hesami *et al.,* 2012) have substantiated this feature by elaborating that the use of different organic and inorganic substrates in appropriate proportion optimizes water and oxygen holding capacity thus allowing better nutrient uptake required for sufficient growth and development.

Treatments

T_1 :	**Perlite**
T_2 :	Perlite + FYM (1:1)
T_3 :	Cocopeat
T_4 :	Cocopeat + FYM(1:1)
T_5 :	Perlite + Cocopeat + FYM (1:1:1)
T_6 :	Soil+ FYM (Control)

Table.1 Effect of different growing media on plant height and number of leaves in strawberry cv. Chandler

Treatments	Plant Height (cm)			Number of leaves per plant		
	2016	2017	Pooled	2016	2017	Pooled
T_1 Perlite	28.19	28.48	28.34	18.33	16.55	17.44
T_2 Perlite + FYM (1:1)	29.38	28.88	29.19	16.63	19.98	18.31
T_3 Cocopeat	26.13	26.18	26.15	14.59	15.74	15.56
T_4 Cocopeat + FYM (1:1)	26.75	26.28	26.51	15.37	16.58	16.44
T_5 Perlite + Cocopeat + FYM (1:1:1)	27.63	27.00	27.09	16.30	17.91	16.25
T_6 Soil + FYM	25.38	25.18	25.28	13.75	15.65	14.70
$CD_{0.05}$	1.36	0.76	0.79	0.93	1.93	1.18

Table.2 Effect of different growing media on leaf area and number of crowns in strawberry cv. Chandler

Treatments	Leaf area per ten leaves $(cm)^2$			Number of crowns		
	2016	2017	Pooled	2016	2017	Pooled
T_1 Perlite	125.67	130.07	127.87	3.10	2.65	2.88
T_2 Perlite + FYM (1:1)	135.77	134.40	135.08	3.15	2.80	2.98
T_3 Cocopeat	124.80	126.39	125.60	2.69	2.68	2.68
T_4 Cocopeat + FYM (1:1)	123.81	126.41	125.11	2.49	2.63	2.56
T_5 Perlite + Cocopeat + FYM (1:1:1)	125.22	126.74	125.98	2.85	2.63	2.74
T_6 Soil + FYM	120.25	121.23	120.74	2.45	2.60	2.53
$CD_{0.05}$	2.30	2.50	1.38	NS	NS	NS

Table.3 Effect of different growing media on root length, number of runners and length of runners in strawberry cv. Chandler

Treatments	Root length (cm)			Number of runners		
	2015	2016	Pooled	2015	2016	Pooled
T_1 Perlite	18.91	20.63	19.13	37.00	41.50	39.25
T_2 Perlite + FYM (1:1)	18.38	19.41	19.16	40.25	39.75	40.00
T_3 Cocopeat	16.44	17.49	16.70	31.75	36.00	34.75
T_4 Cocopeat + FYM (1:1)	16.31	17.13	16.72	32.50	36.50	34.50
T_5 Perlite + Cocopeat + FYM (1:1:1)	17.63	18.06	17.85	35.50	37.75	36.25
T_6 Soil + FYM	14.75	15.00	14.88	31.00	31.50	31.25
$CD_{0.05}$	1.76	2.00	2.80	1.64	1.73	1.14

Table.4 Effect of different growing media on yield per plant and yield per hectare in strawberry cv. Chandler

Treatments	Yield per plant (g)			Yield per ha (t/ha)		
	2016	2017	Pooled	2016	2017	Pooled
T_1 Perlite	194.77	208.00	201.39	48.69	52.00	50.35
T_2 Perlite + FYM (1:1)	201.39	205.23	203.32	50.35	51.31	50.83
T_3 Cocopeat	186.33	191.95	189.14	46.58	47.99	47.29
T_4 Cocopeat + FYM (1:1)	186.97	194.06	190.52	46.74	48.52	47.63
T_5 Perlite + Cocopeat + FYM (1:1:1)	192.97	200.30	196.64	48.24	50.08	49.16
T_6 Soil + FYM	183.52	186.69	185.11	45.88	46.67	46.28
$CD_{0.05}$	1.44	0.91	0.79	0.36	0.23	0.19

Effect of growing media on fruit yield

From the data presented in Table 4, it is apparent that the differences among various treatments were found to be significant in respect of berry yield per plant and yield per hectare during both the years of investigation. The pooled data reveals that the maximum berry yield per plant (203.32 g) and yield per hectare (50.83 t/ha) was observed under perlite + FYM (T_2) treatment. However, minimum berry yield per plant (185.11 g) and yield per hectare (46.28 t/ha) was recorded under soil + FYM (T_6) treatment. The positive influence of perlite and its mixtures on better root development may result in improved aeration thus forming greater root system which may have promoted shoot nutrient uptake leading to increased berry yield. Similar reports indicating of increased yield in perlite and its mixtures have been reported in Sweet Charlie strawberry (Cantliffe *et al.*, 2008) and Camarosa strawberry (Hochmuth 2008).

The results obtained in these studies are in harmony with the findings of Linardakis and Manios (1991), Cantliffe *et al.*, (2008), Yavari *et al.*, (2008), Mashadi *et al.*, (2009) and Rostami *et al.*, (2014), who also observed that the yield of strawberry significantly differed when substrates composed of different ratios of cocopeat, perlite and FYM were used. Different combinations of media have also been reported to improve aeration resulting in the formation of better root system (Yuan *et al.*, 1996 and Verdonck and Demeyer, 2004) and resulting in higher yield (Du *et al.*, 2007 and Albaho *et al.*, 2009).

A critical analysis of the results obtained during the present course of investigations leads to the conclusion that among the different growing media used, perlite in combination with FYM (1:1) is the most appropriate media for obtaining better growth, higher runner production and better yield of strawberry.

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