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Influence of soilless media and containers on shoot growth of strawberry *Fragaria* x *ananassa* Duch cv Sweet Charlie

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ABSTRACT

The shoot growth of strawberry, *Fragaria* x *ananassa* Duch plants grown hydroponically in different substrates of cocopeat + perlite + vermicompost (3:1:1, 4:0:1, 4:1:0, 4:1:1 and 4:1:2) was studied in comparison to soil cultivation in hi-tech greenhouse at CCS Haryana Agricultural University, Hisar, Haryana. The shoot growth of strawberry plants in three types of containers (polyethylene bags and PVC and earthen pots) in two different sizes was also studied. The results indicated that application of soilless substrate improved indices of shoot growth of strawberry. The maximum shoot length (23.60 cm), fresh and dry weight (29.60 and 8.11 g respectively) and root/shoot ratio (0.67) were obtained in interaction M_1 (soilless substrate and large sized earthen pot) while minimum was observed in the interaction M_0C_1 combination. The different containers improved the growth parameters; the maximum increase was in earthen pots followed by PVC pots and polyethylene bags. The present findings highlight the use of substrate (3:1:1) and earthen pots which was best for shoot growth parameters of strawberry followed by substrates 4:1:2 and 4:1:1 and PVC pots.

Keywords: Hydroponics; polyhouse; Sweet Charlie, shoot growth, soilless media

INTRODUCTION

The cultivated strawberry, *Fragaria* x *ananassa* Duch is one of the most delicious, refreshing and important soft fruit of the world. Popularity of strawberries can be judged from the fact that their production has more than doubled over the past two and a half decades (http://faostat.fao.org) ie from 2024 thousand tons in 1985 to 4366 thousand tons in 2010. In India, Maharashtra is the leading state in the production of strawberry. It is also cultivated in Uttar Pradesh, Uttrakhand, Jammu and Kashmir, hills of Darjeeling (West Bengal), Himachal Pradesh (Sharma and Budiyala 1980) and Haryana.

In recent past the strawberry cultivation has been becoming popular in India due to very high returns per unit area. But the main problem with its cultivation is the loss of plants due to soil borne pathogens, nematodes and the occurrence

of soil limiting factors. Conventional soil-based cultivation systems are also not water efficient mainly due to loss by excessive irrigation, leaching and evaporation. Thus increased demand for a suitable technology adapted to soilless culture (De Rijck and Schrevens 1998). Soilless culture may be an effective alternative to soil-based cultivation (Albaho et al 2008) and exploitation of local materials for use as growing media with specific physico-chemical properties (Ortega et al 1996). The properties of different materials used as growing substrates exhibit direct and indirect effects on plant growth and production (Verdonck et al 1981). Cocopeat is an organic substrate for strawberry which has aerial porosity and a good capacity of maintaining water and nutrient whereas perlite has rich inorganic materials such as iron, sodium and calcium (Djedidi et al 1999). Vermicompost applications in soilless culture increased strawberry growth and yields significantly (Arancon et al 2004) because it contains available forms of nutrients for plant uptake such as nitrates, exchangeable phosphorus, potassium, calcium and magnesium (Edwards and Burrows 1988). Vegetative growth, yield and quality were improved with the use of soilless substrate compared to the soil or with addition (Ercisli et al 2005, Marinou et al 2013, Ebrahimi et al 2012). The use of coconut husk in black bags produced the highest values of number of leaves, shoot length and total leaf area (Hassan et al 2011). The objective of the present study was to compare the performance of shoot growth of strawberry in different mixtures of cocopeat, perlite and vermicompost and three types of containers of two sizes.

MATERIAL and METHODS

Strawberry, *Fragaria* x *ananassa* Duch cv Sweet Charlie plants were grown under natural light condition during October 2013-14 in the hi-tech greenhouse at CCS Haryana Agricultural University, Hisar in western Haryana. Three substrates viz cocopeat, perlite and vermicompost were used to create five treatments in addition to control which were M_0 (soil cultivation (control), M_1 (cocopeat + perlite + vermicompost 3:1:1), M_2 (cocopeat + perlite + vermicompost 4:0:1), M_3 (cocopeat + perlite + vermicompost 4:1:0), M_4 (cocopeat + perlite + vermicompost 4:1:1), M_5 (cocopeat + perlite + vermicompost 4:1:2) and three types of containers viz C_1 (polyethylene bags 16 x 16 cm and 20 x 20 cm), C_2 (PVC pots 15 and 25 cm) and C_3 (earthen pots 15 and 25 cm). The runners were planted during the second week of October directly in the substrates after treating with carbendazim and monocrotophos. Holes were made at the bottom of each container to allow the drainage of excess water. The six substrate mixtures with five replications/treatment (5 plants/replication) were arranged in single row on a greenhouse trough. At the end of the growing season each plant was evaluated in terms of shoot length, fresh and dry shoot

weight and root/shoot ratio. Data were tested for normality and subjected to analysis of variance (ANOVA) suggested by Gomez and Gomez (1984). Significant differences between mean values were obtained using the completely randomized design and following three way ANOVA. Statistical analyses were performed using OPSTAT (Statistics Analytical Software).

RESULTS and DISCUSSION

The interaction effects between the substrate and container, substrate and the container size, type and size of container were found significant while the interaction for all the three factors was non-significant (Table 1). Among the three different containers used earthen pot produced maximum shoot length (20.10 cm) followed by PVC pot (19.35 cm) and the minimum shoot length (17.66 cm) was observed in plants grown in polyethylene bag. The larger size container gave maximum shoot length in all three types of containers. The substrate composition (3:1:1) gave maximum shoot length of 22.11 cm followed by M_5 (20.69 cm) and M_4 (20.12 cm) and the minimum shoot length was found in M_0 (15.21 cm) followed by M_3 (17.78 cm). Thus it was evident that the strawberry plants grown in M_1 substrate with large size earthen pots gave maximum (23.60 cm) shoot length and was found best among all the treatments. This might be due to the better water retention by the soilless substrate, air filled porosity, gas diffusion and better nutrient availability to the plants. These results are in agreement with the work of Hassan et al (2011) who found that coconut husk gave highest plant height over peanut husk and control (soil cultivation) but there were no significant differences between black poly bags and white plastic containers. These results are contrary to the work of Tariq et al (2013) who observed that soil cultivation gave highest shoot length as compared to coconut coir and peat moss.

Strawberry plants grown in different soilless media and different sizes of containers produced wide differences in shoot fresh weight (Table 2). The two way interactions between substrates and containers, substrates and containers size and that of all these factors were found significant. But there was non-significant interaction between the container and size. Among various substrates tried, cocopeat + perlite + vermicompost (3:1:1) gave greatest shoot fresh weight (26.42 g) followed by M_5 (21.35 g) and M_4 (18.98 g) while the lowest fresh shoot weight was observed with M_0 (12.23 g) followed by M_3 (14.29 g). The large size earthen pot gave highest fresh shoot weight (20.63 g) followed by large size PVC pot (18.93 g) and the lowest fresh shoot weight was observed in small polybag (15.61 g). Strawberry plants grown with 3:1:1 substrate in large earthen pot resulted in maximum fresh shoot weight (29.60 g) and was found best among all the treatments. This could be due to the reason that

Table 1. Effect of soilless media and containers on shoot length (cm) of strawberry cv Sweet Charlie

Type and size of container	Soilless medium						Mean
	M_0	M_1	M_2	M_3	M_4	M_5	
Polyethylene bag							
Small size	13.20	20.27	17.13	13.87	17.40	18.30	16.70
Large size	14.10	21.80	17.97	17.70	19.93	20.23	18.62
Mean	13.65	21.04	17.55	15.79	18.67	19.27	17.66
PVC pot							
Small size	15.40	21.97	18.27	18.27	20.37	20.63	19.15
Large size	15.90	22.27	18.60	18.57	20.57	21.37	19.55
Mean	15.65	22.12	18.44	18.42	20.47	21.00	19.35
Earthen pot							
Small size	16.27	22.77	18.80	18.67	20.93	21.60	19.84
Large size	16.40	23.60	18.97	19.60	21.50	22.03	20.35
Mean	16.34	23.19	18.89	19.14	21.22	21.82	20.10
Mean for media and containers							
C_1	13.65	21.03	17.55	15.78	18.67	19.27	17.66
C_2	15.65	22.12	18.43	18.42	20.47	21.00	19.35
C_3	16.33	23.18	18.88	19.13	21.22	21.82	20.09
General mean	15.21	22.11	18.29	17.78	20.12	20.69	19.03

CD for factor A = 0.38, Factor B= 0.27, Factor C= 0.22, A x B= 0.65, A x C= 0.53, B x C= 0.38, A x B x C= NS

Factor A= Soilless media, Factor B= Containers, Factor C= Size, NS= Non-significant

substrate caused better exchange of elements especially cations inside the substrate and they distributed humidity properly around the root zone and it was finally effective in plant growth. These results are in conformity with the findings of Marinou et al (2013) and Ebrahimi et al (2012) who found maximum shoot fresh weight from cocopeat + perlite. They observed that as the sand increased in the substrate the shoot fresh weight was decreased.

There were significant differences in shoot dry weight produced per plant on account of different substrates, types and the size of containers (Table 3). The two way interaction between substrates and containers, substrates and containers size, type and size of containers and that of all three factors were found significant. The data given in Table 3 reveal that among the different soilless substrates tested the M_1 gave highest shoot dry weight (6.36 g) followed by M_5 (5.46 g), M_4 (5.14 g) and

Table 2. Effect of soilless media and containers on shoot fresh weight (g) of strawberry cv Sweet Charlie

Type and size of container	Soilless medium						Mean
	M_0	M_1	M_2	M_3	M_4	M_5	
Polyethylene bag							
Small size	8.20	24.00	15.87	12.60	16.60	16.40	15.61
Large size	12.93	24.60	14.63	14.03	17.80	20.70	17.45
Mean	10.57	24.30	15.25	13.32	17.20	18.55	16.53
PVC pot							
Small size	12.07	23.40	12.63	12.60	17.80	20.20	16.45
Large size	12.60	28.60	14.70	14.60	19.70	23.40	18.93
Mean	12.34	26.00	13.67	13.60	18.75	21.80	17.69
Earthen pot							
Small size	13.00	28.32	14.93	14.80	19.60	21.40	18.68
Large size	14.60	29.60	14.07	17.10	22.40	26.00	20.63
Mean	13.80	28.96	14.50	15.95	21.00	23.70	19.65
Mean for media and containers							
C_1	10.57	24.30	15.25	13.32	17.20	18.55	16.53
C_2	12.33	26.00	13.67	13.60	18.75	21.80	17.69
C_3	13.80	28.96	14.50	15.95	21.00	23.70	19.65
General mean	12.23	26.42	14.47	14.29	18.98	21.35	17.96

CD for Factor A= 0.63, Factor B= 0.44, Factor C= 0.36, A x B= 1.09, A x C= 0.89, B x C= NS, A x B x C = 1.54

Factor A= Soilless media, Factor B= Containers, Factor C= Size, NS= Non-significant

M_2 (4.44 g) and the lowest dry shoot weight was found in control (3.83 g). In case of containers, earthen pot gave maximum shoot dry weight (5.71 g) while minimum shoot dry weight per plant was recorded in polyethylene bags (4.32 g). The M_1 substrate with large earthen pot produced maximum shoot dry weight per plant (8.11 g) and the lowest (2.88 g) was recorded in control in small polyethylene bags. It could be due to the reason that soilless substrates improved the water and nutrient consumption and maintained porosity which is better for plant growth. Similar results were observed by Marinou et al (2013) who suggested that maximum shoot dry weight (30.1 g) was achieved by using cocopeat and pumice in 1:1 ratio.

Root/shoot ratio in strawberry plants was affected significantly due to substrate composition, type and size of the containers (Table 4). The two factor interaction between substrates and type of

Table 3. Effect of soilless media and containers on shoot dry weight (g) of strawberry cv Sweet Charlie

Type and size of container	Soilless medium						Mean
	M_0	M_1	M_2	M_3	M_4	M_5	
Polyethylene bag							
Small size	2.88	5.31	3.89	3.81	4.38	4.73	4.17
Large size	3.58	5.98	3.93	3.82	4.73	4.84	4.48
Mean	3.23	5.64	3.91	3.81	4.56	4.79	4.32
PVC pot							
Small size	3.73	5.99	4.06	3.85	4.84	4.91	4.56
Large size	3.89	6.05	4.31	3.94	4.93	5.09	4.70
Mean	3.81	6.02	4.19	3.90	4.89	5.00	4.63
Earthen pot							
Small size	4.08	6.71	4.31	4.14	4.98	5.18	4.90
Large size	4.84	8.11	6.13	5.00	6.98	8.01	6.51
Mean	4.46	7.41	5.22	4.57	5.98	6.60	5.71
Mean for media and containers							
C_1	3.23	5.64	3.91	3.81	4.56	4.79	4.32
C_2	3.81	6.02	4.19	3.90	4.89	5.00	4.63
C_3	4.46	7.41	5.22	4.57	5.98	6.60	5.71
Mean	3.83	6.36	4.44	4.09	5.14	5.46	4.89

CD for Factor A= 0.16, Factor B= 0.11, Factor C= 0.09, A x B= 0.27, A x C= 0.22, B x C= 0.16, A x B x C = 0.38

Factor A= Soilless media, Factor B= Containers, Factor C= Size

containers, substrate and container size, and container and their size except all the factors of the variation were found significant. A perusal of data given in Table 4 suggest that M_1 substrate gave maximum root/shoot ratio (0.55) followed by M_5 (0.52) while minimum root/shoot ratio was observed in control (0.32). Among different containers used, the earthen pots (0.50) resulted in highest root/shoot ratio followed by PVC pots (0.47) and the lowest root/shoot ratio was observed in polyethylene bags (0.44). The size of the container also affected the root/shoot ratio significantly. The strawberry plants when grown with M_1 substrate in large size earthen pots gave maximum (0.67) root/shoot ratio and was found best among all the treatments. It could be due to the reason that soilless substrates improved the water and nutrient consumption and maintained porosity. This result is also in agreement with the work of Ebrahimi et al

Table 4. Effect of soilless media and containers on root/shoot ratio of strawberry cv Sweet Charlie

Type and size of container	Soilless medium						Mean
	M_0	M_1	M_2	M_3	M_4	M_5	
Polyethylene bag							
Small size	0.29	0.47	0.41	0.40	0.43	0.44	0.41
Large size	0.32	0.54	0.50	0.48	0.50	0.51	0.48
Mean	0.31	0.51	0.45	0.44	0.47	0.48	0.44
PVC pot							
Small size	0.31	0.50	0.47	0.43	0.48	0.49	0.45
Large size	0.34	0.58	0.52	0.44	0.56	0.56	0.50
Mean	0.33	0.54	0.50	0.44	0.52	0.53	0.47
Earthen pot							
Small size	0.32	0.52	0.44	0.41	0.49	0.51	0.45
Large size	0.32	0.67	0.51	0.52	0.62	0.63	0.55
Mean	0.32	0.60	0.48	0.47	0.56	0.57	0.50
Mean for media and containers							
C_1	0.31	0.51	0.45	0.44	0.47	0.48	0.44
C_2	0.33	0.54	0.50	0.44	0.52	0.53	0.47
C_3	0.32	0.60	0.48	0.47	0.56	0.57	0.50
Mean	0.32	0.55	0.48	0.45	0.51	0.52	0.47

CD for factor A= 0.02, Factor B= 0.02, Factor C= 0.01, A x B= 0.04, A x C= 0.03, B x C= 0.02, A x B x C= NS

Factor A= Soilless media, Factor B= Containers, Factor C= Size, NS= Non-significant

(2012) who suggested that the highest shoot/root ratio was obtained from (peat + sand + perlite) treatment.

CONCLUSION

The present findings highlight the putative use of organic medium ie cocopeat, perlite and vermicompost as substrate in strawberry culture. The performance of strawberry plants is markedly influenced by soilless media. It could be due to the alteration of physico-chemical properties (such as porosity, water content and air capacity) of raw material and hence the air and water balance in the root environment. Further research study is necessary for the complete exploitation of the putative use of substrate mixtures as pure or composted material and of their ability to improve physico-chemical properties as substrate medium, indentifying the exact ratio mixed into substrates as well as appropriate

container type (to improve hydraulic properties of the media) for hydroponically grown crops.

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