Advances in Environmental Biology, 4(2): 325-328, 2010
ISSN 1995-0756

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ORIGINAL ARTICLE

Effect of different Substrates and Varieties on Yield and Quality of Strawberry in Soilless Culture

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Sasan Jafarnia, Abdollah Hatamzadeh, Ali Tehranifar: Effect of different Substrates and Varieties on Yield and Quality of Strawberry in Soilless Culture: *Adv. Environ. Biol., C(C): CC-CC, 2010*

ABSTRACT

Most growing media for strawberries in soilless culture are peat moss, rockwool, coir, perlite or some other mixtures. Nowadays, using mixture of peat moss and perlite is one of the mostly used substrate for production of hydroponic strawberries in developing countries. The effects of three different media based on 100%: 0, 80%: 20% and 60%: 40% v/v perlite and peat moss were evaluated on quantity and quality of three varieties of strawberry (*Fragaria ananassa*) in soilless culture. Perlite/ peat moss substrate 100%:0% ratio (v/v) produced the most number of leaves and flowers number and the number of fruits and fruit dry weight were the highest in both substrates of 100%:0 and 60%:40% perlite/peat moss. Fresno variety had the highest number of leaves production between three studied varietie., However, both Fresno and Selva had the highest number of fruits and fruit dry weight and the difference between these two varieties were not significant. All in all, the results showed that based on the goals of planting strawberries, both Fresno and Selva varieties and also 100%:0 and 60%:40% perlite/peat moss are the best ones in production of strawberries in Iran.

Key words: Peat moss, Perlite, Soilless Culture, Strawberry, Variety.

Introduction

Hydroponic plant production has been practiced for several millennia and it permits crops to be grown where no suitable soil exists or where the soil is contaminated in some manner. In one of the seven wonders of the ancient world, the Hanging Gardens of Babylon, plants were grown in a steady stream of water [12,22]. In addition, more complete control of the environmental factors that affect plant growth and yield (root environment, fertigation, light temperature, humidity, etc.) is possible [11].

Strawberry is commonly produced as early spring crop or out-of-season in open field, glasshouse or polyethylene tunnel. Pests and diseases in soil culture have always been problems especially in protected areas [7]. Suitable mixture of substrate in soilless culture within greenhouse systems, extend harvesting duration, out of season strawberry production and increase in yield [24]. Material properties of substrate exhibit direct and indirect effects on plant physiology and production [4]. In order to grow strawberry, different substrates such as peat moss, coconut coir, perlite, rockwool and pine bark have been used. However, peat has been the best substrate for hydroponic culture [14]. There are different reports related to use of zeolite and perlite as substrates in hydroponic culture [19]. Kanazirska *et al*. [13] reported decreasing potassium exchange in substrates of perlite and mixtures of perlite/zeolite cucumber hydroponic culture. Due to high price and not easy availability of peat moss, producers usually try to replace it by other substrates like perlite or zeolite, but in Iran there are rich natural sources of peat moss in the north of Iran and, as a result, it can be used in hydroponic systems as a cheap substrate individually or combined with perlite.

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Other factors like varieties, temperature, and the rate of humidity and size of container can also affect the plant growth and fruit yield of strawberry [5]. The variety of strawberry is completely related to environmental factors and although some varieties are the best ones in one part of the world, they may produce lower amount of fruits in other parts or vice versa [10]. The objective of this investigation was to determine the effects of perlite and peat moss as substrates and using three different varieties on the number of leaves, flower numbers and weigh and number of fruits in vertical system soil-less culture.

Materials and methods

The used strawberry varieties (Kordestan, Fresno and Selva) were obtained from the agricultural center of Sanandaj and Hashtgerd. Selection of these varieties was based on their yields, accessibility and abundance. The experiment design was split plot based on a randomized complete block. Therefore, type of substrates was the primary factor and the type of varieties was secondary factor. Moreover, the number of replication was three. Three different media mixtures were 1:0, 0.8:0.2 and 0.6:0.4 v/v ratio of perlite and peat moss.

The hydroponic system was vertical and the nutrition system was open. The vertical system was made of four Styrofoam pots at 25 cm diameter in 1.1 meter height. The greenhouse operated at 10-15°C during night and 20-25°C daily temperature. The columns were fixed at 1.3 columns m^{-2} and 21 plants m^{-2} density (16 plants $column^{-1}$). Lieten [15] nutrient solution containing NO_3, NH_4, H_2PO_4, SO_4, K, Ca and Mg with 11.5, 0.5, 1.5, 1.5, 3.5, 4.5 and 1.5 mmol L^{-1} and micronutrients Fe, Mn, Zn, B and Cu with 20, 20, 10, 12 and 0.75 µmol L^{-1} were used based on 100-250 mL $plant^{-1}$ day^{-1} depending on growth stage. The pH and EC of nutrient solution were adjusted to 5.8 and 0.9-1.4 dS m^{-1}, respectively. Several factors as the most important indicators of generative and productive traits were calculated. The number of leaves, flowers number and the number of fruits were measured three times a week and the total number of them in each replicate during the growth season used in variance analysis. Fruit dry weight was taken by drying 100 g fresh fruit at 70°C in oven for 48 hour.

Data was analyzed by software SPSS. The analysis of variance and Duncan multiple range test were used to find significant differences in the means.

Results

Variance analysis of generative traits and production was significant in most cases ($P<0.05$). Comparisons of media showed that the highest leaf (9.639) and flower numbers (3.153) were related to 100% perlite, the highest fruit dry weight (6.706 & 5.153 g) was obtained in 60% perlite + 40% peat moss and 100% perlite, respectively, and there is no significant difference in the number of fruits on different substrates (table 1). Although the number of leaves and fruits in 80% perlite + 20% peat moss had a little difference, this difference was not significant ($P<0.05$) (table 1). The lowest value of fruit dry weight was related to 80% perlite + 20% peat moss (table 1).

Data of the effects of varieties on these parameters showed that the highest number of leaves (10.361) was obtained in Fresno, whereas the highest number of fruits (0.750 & 0.541) and the highest fruit dry weight (5.889 & 5.874) were related to Selva and Fresno, respectively, and the difference between these values were not significant at $P<0.05$ (table 2). There was no significant difference between values of flower numbers in all cases (table 2).

Interaction between variety and substrate on leaves number showed that the highest number of leaves was obtained in Fresno variety cultured in 100% perlite substrate and the lowest value was related to Kordestan variety at the same substrate. These values had a significant difference from other values ($P<0.05$); However, the difference between other values was not significant (table 3). Considering the data on interactions between variety and substrate on flowers number, the highest flower numbers were obtained when two varieties of Selva and Kordestan planted in 100% perlite and the lowest value was related to kordestan variety in 60% perlite + 40% peat moss. These values had a significant difference from other values ($P<0.05$) (table 4).

Data related to Interaction between variety and substrate on fruits number and fruit dry weight showed that highest values were obtained from selva in 100% perlite and Fresno in 60% perlite + 40% peat moss. These values were significantly different from other values, but the difference between these two values in each group was insignificant ($P<0.05$). Other values in both groups were similar and there was no significant difference between them (table 5 & 6).

Discussion

Leaves are responsible for producing nutrients and regulating metabolic activities in plants and they also protect flowers and fruits during periods in which the weather is not suitable for plants [9]. paying attention to this topic is so important when one season varieties like Fresno is used [9]. The number of leaves was the highest in Fresno in 100% perlite. There are several studies in which it has presented that perlite is the best media for strawberries in comparison with other substrates having peat moss [1,2,3].

Table 1: Effect of substrate on quantitative properties

Substrate	Leaves number	Flowers number	Fruits number	Fruit dry weight (g)
100% perlite	9.639a	3.153a	0.661a	5.153a
80% perlite + 20% peat moss	8.139b	1.694b	0.402a	3.653b
60% perlite + 40% peat moss	7.917b	2.000b	0.569a	6.706a

Table 2: Effect of variety on quantitative properties

Variety	Leaves number	Flowers number	Fruits number	Fruit dry weight
Fresno	10.361a	2.167a	0.541a	5.874a
Selva	7.944b	2.667a	0.750a	5.889a
Kordestan	7.389b	2.014a	0.291b	3.681b

Table 3: Interaction between variety and substrate on leaves number

Interaction between variety and substrate on leaves number	100% perlite	80% perlite + 20% peat moss	60% perlite + 40% peat moss
Fresno	12.417a	9.104b	9.205b
Selva	10.042b	6.257c	8.650b
Kordestan	6.250c	8.926b	8.650b

Table 4: Interaction between variety and substrate on flowers number

Interaction between variety and substrate on leaves number	100% perlite	80% perlite + 20% peat moss	60% perlite + 40% peat moss
Fresno	2.110b	2.680b	4.157a
Selva	3.917a	1.734b	2.564b
Kordestan	2.448b	1.652b	1.125c

Table 5: Interaction between variety and substrate on fruits number

Interaction between variety and substrate on leaves number	100% perlite	80% perlite + 20% peat moss	60% perlite + 40% peat moss
Fresno	0.178b	0.165b	1.666a
Selva	1.500a	0.500b	0.456b
Kordestan	0.323b	0.780b	0.122b

Table 6: Interaction between variety and substrate on fruit dry weight

Interaction between variety and substrate on leaves number	100% perlite	80% perlite + 20% peat moss	60% perlite + 40% peat moss
Fresno	2.750b	2.789b	13.250a
Selva	11.500a	2.750b	5.465b
Kordestan	3.890b	7.800b	1.440b

The number of flowers, fruits and fruit dry weight are related to each other and according to Garate *et al*. [6] and increase in the number of flowers causes increase of fruits number and fruit dry weight. Han *et al*. [8] presented that these productive factors are completely related to the diameter of crowns, which can be used to predict plant yield potential [9]. according to effects of varieties, it was obvious that Selva had higher values than Fresno, but the difference between them were not significant. By considering both effects of varieties and media, Selva had the highest value in media of 100% perlite; however, Fresno had the highest values of fruit numbers, the number of flowers and fruit dry weight in 60% perlite + 40% peat moss. There are many studies which cited that although some varities have the highest yields in one media, changing the media can change their potential yields significantly [17,16] mentioned that substrate of mixed perlite and peat moss is useful for varieties which need high amount of Copper to produce high quality strawberries, but in some varieties growing in peat substrate the quantity of produced strawberries increases. According to them, type of media has to be defined based on necessities of producers and market places. In this study 100% perlite and 60% perlite + 40% peat moss were the best substrates for two different varieties and in other studies, also, it was presented that these two substrates had better results than other types of perlite and peat moss composition on flowers number, the number of fruits and fruit dry weight [20,21].

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