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Full Length Research Paper

Date-peat as an alternative in hydroponic strawberry production

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Date palm (*Phoenix dactylifera*) is one of the most important agricultural products for export in Iran. According to published statistics by FAO in 2008, more than 244000 ha of farm lands in Iran have been allocated to palm cultivation. Large amounts of palm wastage are thrown away without any usage annually. By contrast, cocopeat, which is produced from coconut trees, is imported for different purposes per annum. Thus, in order to find an alternative compound to cocopeat, an experiment was conducted with different combinations of palm leaf petioles (date-peat), cocopeat and perlite in hydroponic culture beds for strawberry under controlled conditions. The results showed that the best combination was achieved when a mixture of two parts of perlite, one part date-peat and one part cocopeat resulted in increased fruit yield, fruit number, chlorophyll content and leaf area. Additionally, the highest vitamin C content was observed in 3: 1 ratio of perlite and cocopeat treatment. On the other hand, application of three parts of date-peat + one part of cocopeat and also three parts of cocopeat + one part of date-peat, led to increased total soluble solids however there was no significant difference between mixtures. Nowadays, the growth medium in hydroponic bed mainly consists of mixture of cocopeat and perlite. Presented results suggest that palm wastages (date-peat) could be a good alternative to be partly substitute coconut fiber for strawberries and possibly other hydroponic crops.

Key words: Cocopeat, date-peat, perlite, strawberry, hydroponic culture.

INTRODUCTION

In recent years, drought stress and water shortage is considered as a dilemma in many parts of the world. Iran with semi-arid climate and average annual rainfall of 247 mm is not an exception. Therefore, the use of green-houses and soilless culture method is an efficient strategy under these conditions. Soilless culture is defined as plant production without soil, which is often called hydroponic culture (Olympios, 1993). Compared with soil culture, soilless cultivation has higher water use efficiency and led to increase in yield (Rouphael et al., 2004). These systems also led to better water and fertilizer management (Al-Raisy et al., 2010). While pests and diseases are major problems in soil culture (Gul et al., 2005), hydroponic cultures are mainly free from weed seeds and also, incidence of root pathogens are lower (Cantliffe et al., 2007).

Strawberry (*Fragaria ananassa*) is one of the major crops in hydroponic culture. Because of its taste, scent and high vitamin content, strawberry is well known all over the world and is a common fruit in food diets (Tabatabaei et al., 2006). About 0.67% of global strawberry production is from Iran, which is doubled in the last two decades. Since Iran has a unique climate for strawberries, it has a potential to be one of the main world producers in future (Tehranifar and Sarsaefi, 2002). In many countries, strawberry is commonly field cultivated in soil. In temperate regions, such as North and Central Europe, Korea, Japan and some areas of China,

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Table 1. Different substrate combinations in the experiments.

Symbol	Treatment
P	Perlite
C	Cocopeat
D	Date palm petiole (date-peat)
P1C1	1 part perlite+ 1 part cocopeat
C1D1	1 part cocopeat + 1 part date-peat
P1D1	1 part perlite + 1 part date-peat
P3D1	3 parts perlite + 1 part date-peat
P3D1	3 parts perlite + 1 part cocopeat
C3D1	3 parts cocopeat + 1 part date-peat
C3P1	3 parts cocopeat + 1 part perlite
D3P1	3 parts date-peat + 1 part perlite
D3C1	3 parts date-peat + 1 part cocopeat
P1D1C2	1 part perlite + 1 part date-peat + 2 parts cocopeat
P1D2C1	1 part perlite + 2 parts date-peat + 1 part cocopeat
P2D1C1	2 parts perlite + 1 part date-peat + 1 part cocopeat

Table 2. Some physical and chemical properties of cocopeat and date-peat media.

Variable	Ability to maintain moisture (times of dry weight)	Ec (mmhos.cm^{-1})	pH
Date-peat	7	7.09	6.51
Cocopeat	8.5	1.30	6.67

it is also cultivated under hydroponic conditions in greenhouses (Cantliffe et al., 2007). Greenhouse production results in higher yield, forcing possibilities, and better pests control and thus, reducing the usage of chemicals which could be a benefit for fruits quality (Dinar, 2003). Growth media and nutrition are the most important factors in hydroponic production. Application of organic materials as substrates for hydroponic culture media was reported by Tilt and Bilderback (1983). Some studies express the advantage of pine leaves (Paranjpe et al., 2003) and rice (Caso et al., 2009) bran as media for soilless culture of strawberries. Furthermore, cocopeat in media improves water holding capacity and increases media porosity causing positive effects on physical properties (Abad et al., 2002; Fornes et al., 2003). The main median hydroponic systems are a mixture of perlite and cocopeat. Cocopeat is obtained from the coconut (*Cocos nucifera*) that is not grown in Iran. The purpose of this experiment was to understand if date palm wastes (date-peat) can be an alternative for cocopeat in strawberry production.

MATERIALS AND METHODS

The experiment was carried out in a greenhouse located in the Faculty of Agriculture and Natural Resources, Persian Gulf University, Bushehr, Iran during the 2007 to 2008 growth seasons. Strawberry plants (cv. Gavieta) were purchased from a valid nursery in Karaj, Iran. Preparation of culture media was performed in December, 2007. Date palm petioles, which was called date-peat were collected from local date orchards and cocopeat and perlite were bought from the market. At the beginning of the experiment, different combinations of date-peat, cocopeat and perlite were prepared. The combinations are shown in Table 1. Cocopeat was not sterilized but was soaked in water for 24 h and then placed on sieves for exuding excess water. To prepare date-peat, dried parts of petioles (called "Ghondagh" in folk culture of Bushehr province) were used. Petioles were crushed into maximum size of 1 cm by grinder. Later crushed palm petioles were sterilized with water vapor. Physical and chemical properties of cocopeat and date-peat are given in Table 2.

Five liter plastic pots were filled up with different prepared culture media and planted with 3 to 4 leaves strawberry plants on the first days of January. In order to prevent drought stress, plants were irrigated with equal water volumes immediately. To reduce the error, the effect of fertilizer was minimized by using a fixed nourishing solution for plants (common nutrition formula of Hoagland and Arnon), which is used in California University (Hoagland and Arnon, 1950). In order to reduce error, an open solution nutrition system was used. Moreover, equal amounts of nutrition solution were added to each pot. At the beginning of flowering, complete NPK fertilizer (20: 20: 20) was added into the nutrition solution with final concentration of 5: 1000. During whole growth stages, nutrition solution pH was adjusted on 6.5 and EC was fixed on 3.3 mmhos cm^{-1}. These parameters were monitored daily by portable devices. Pots were irrigated three times per month with distilled water to prevent the accumulation of salts and salinity stress induction. Premature flowers, dried leaves and runners were eliminated during the growth season. Fruits with 60 to 70% reddish

pink color were harvested and transferred to the laboratory. In order to determine the effect of treatments on fruits, some qualitative and quantitative characteristics such as fruit yield, fruit size, fruit number, leaf chlorophyll content, leaf area, number of leaves, fruit vitamin C, total soluble solid content in fruit juice and dominant acid were assayed. Leaf chlorophyll content was measured using portable chlorophyll meter (SPAD502, Japan) at the flowering stage. For this purpose, chlorophyll content was measured in three same leaves of each pot and average content was presented as chlorophyll content per pot. Additionally, three leaves from each plant were selected and leaves area were measured by portable leaf area meter (CI_202, USA). Leaves number of each pot were counted simultaneously.

Fruit number was registered at harvest time. Fruits weights were weighed using a digital scale. Fruit volume was determined via water displacement technique (Arzani et al., 1999). Vitamin C content was estimated by Iodine test method. Strawberry juice was diluted with 20 ml distilled water, and 2 ml of starch was used as reagent and finally, this diluted solution was titrated with 0.2 N Potassium Iodine. Titration continued until the solution reached a fixed color and then vitamin C content was estimated by Formula 1 (Hesami et al., 2012):

Mg Ascorbic acid = 0.88 × ml Potassium Iodine

Total soluble solid was measured using a refractometer. Citric acid as dominant acid of fruits was measured by using titration method with 0.2 N NaOH, for this purpose, 10 ml of fruit juice extract was titred with 0.2 N NaOH and then dominant acid was measured by Formula (2):

Mg Dominant acid (Citric Acid) = 100 × ml NaOH × N Citric acid × sample weight $(g)^{-1}$

The experimental design was randomized complete blocks (RCBD) including 15 treatments and 4 replications. All data were subjected to MSTAT-C software for analysis of variance and Duncan's Multiple Range (DMRT) Test was used for means comparison.

RESULTS

Fruit yield and volume

The results revealed that treatment P2D1C1 (2 parts of perlite + 1 part date-peat + 1 part cocopeat) had significant better effect on fruit yield than the other treatments, and fruit yield noticeably increased. Regarding fruit yield P1C1 treatment (1 part perlite + 1 part cocopeat; (control treatment)) was the second best. The treatments D (Date-peat) and C1D1 (1 part cocopeat + 1 part date-peat) had the lowest fruit yield (Table 2). The largest and smallest fruits were related to D and C1D1, respectively (Table 2). However, C1D1 was not significantly different from the other treatments, except for D. Treatment P2D1C1 had the highest fruit number compared with the other treatments while treatment D had the lowest fruit number (Table 2).

Chlorophyll content, leaf area and leaf number

Date-peat as the only substance of the growing media resulted in lowest chlorophyll content of the treatments, but could not be distinguished from treatments C, P1C1, C1D1 and P1D2C1 (Table 3). Changing substances in culture media had effect on leaf area. Treatment P2D2C1 could, with the highest leaf area, be clearly separated from treatments D, D3P1 and C1D1 which had the lowest areas. Also, treatment D3C1 had a large leaf area and was ranked the second best. Growing in a media consisting of date-peat (D) was not successful and reduced leaf area dramatically. The maximum leaf number was observed in those pots which were filled with perlite only. Treatments P3D1 and C3P1 had the highest leaf number. Leaf number generally decreased when date-peat were added.

Vitamin C, TSS and citric acid

Means comparison showed significant difference between treatments. Treatments P3C1 and D had the highest and lowest vitamin C content, respectively (Figure 1). Evaluation of different culture media effects on TSS showed that there is no significant difference between treatments C3D1 and D3C1, but their results were significantly different from the other treatments and showed the highest TSS in fruit juice. On the other hand, treatments D and P1D1C2 had the lowest TSS in fruit juice (Figure 2). There were no significant differences between treatments D, P3D1 and C3P1, which had the highest citric acid contents compared with the other treatments. The lowest citric acid content was achieved using the media P1C1, C3D1 and C1D3 (Figure 3).

DISCUSSION

In general, obtained results showed that application of organic matter in combination with perlite, increased fruit yield, which is in agreement with the study of Tehranifar et al. (2007). They studied the effect of seven growth media on quality and quantity of three strawberry cultivars grown in hydroponic conditions where cocopeat and peat produced the highest fruit yield. On the other hand, perlite, as an effective material to improve porosity, showed an important role in improving growth media based on organic material. The highest yields were obtained by treatments P2D1C1 and secondly by P1C1. This indicated that the higher level of date palm petiole (date-peat) has high ability for moisture saving and can be an important substance in commercial hydroponic production. Increased yield in treatment P2D1C1 can be related to the high leaf area in spite of a relatively low leaf number. The high leaf area caused by this treatment may be the reason of a high level of assimilates causing a high flower/fruit production and finally, higher yield. On the other hand, date-peat as the only substance in the media had diverse effects on fruit yields. As for the application of non-composted date-peat in this experiment, it seems that, probably it contained some

Table 3. Effect of different combinations of culture media on quantity traits of strawberry grown in hydroponic culture.

Treatment	Yield (g plant^{-1})	Fruit volume (cm^3)	Fruit number (-)	Chlorophyll (-)	Leaf area (cm^2)	Leaf number (-)
P	46.58^{h}	7^{bcd}	7^{d}	48.3^{a}	177.3^{abc}	33.25^{a}
C	49.52^{g}	7.25^{bcd}	6.75^{d}	43.97^{ab}	166.3^{abcd}	15.25^{defgh}
D	20.8^{k}	13.25^{a}	2.75^{h}	39.05^{b}	125.7^{d}	10.5^{hi}
P1C1	80.97^{b}	7.25^{bcd}	10.75^{b}	44.17^{ab}	179.9^{abc}	15.25^{defgh}
C1D1	22.05^{k}	5.25^{bcd}	4.5^{fg}	43.95^{ab}	139.4^{cd}	14^{fgh}
P1D1	60.75^{d}	9.75^{d}	6.5^{de}	44.9^{a}	168.3^{abcd}	13.5^{ghi}
P3D1	76.82^{c}	7.25^{bcd}	10.75^{b}	46.53^{a}	166.8^{abcd}	26.75^{b}
P3C1	60.92^{d}	7.5^{bcd}	8.5^{c}	47.33^{a}	183.6^{abc}	24.25^{bc}
C3D1	52.6^{f}	7.75^{bcd}	7^{d}	46.5^{a}	165.4^{abcd}	18.75^{def}
C3P1	34.85^{i}	9.5bc	3.75^{g}	46.65^{a}	180.7^{abc}	26.5^{b}
D3P1	46.65^{h}	10^{b}	4.75^{fg}	45.2^{a}	144.6^{bcd}	15^{efgh}
D3C1	49.33^{g}	7^{bcd}	7^{d}	48.65^{a}	187^{ab}	17.25^{defg}
P1D1C2	27.1^{j}	7.25^{bcd}	4^{g}	47.42^{a}	177.4^{abc}	19.75^{cde}
P1D2C1	44.38^{h}	8^{bcd}	5.5^{ef}	44.6^{ab}	178^{abc}	16.5^{defg}
P2D1C1	88.88^{a}	6.5^{cd}	13.75^{a}	47.4^{a}	201.4^{a}	20^{d}

P: perlite; C: cocopeat; D: date-peat; means with similar letter(s) are not significant at the 5% probability level.

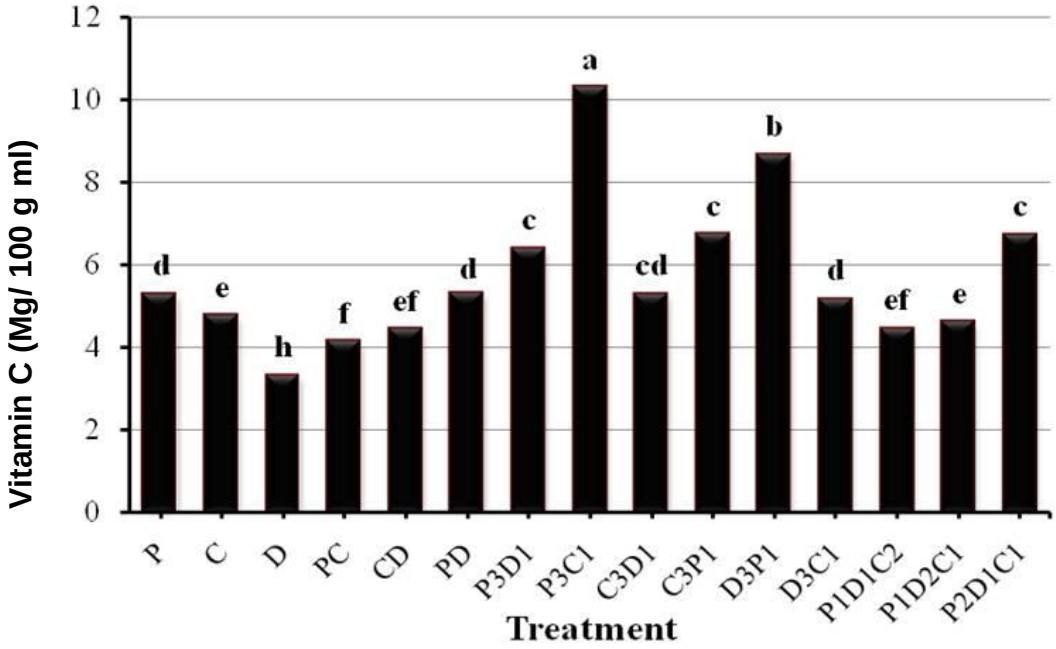

Figure 1. Effect of different combinations of culture media on rate of vitamin C in hydroponic culture. (Means with similar letter are not significant at 5% probability level).

growth inhibitors with adverse effects on fruit production. This possible negative inhibitory effect was reduced adding perlite or crushed petiole combined with cocopeat and perlite, avoiding that the concentration of inhibitory compounds reduced growth and yield. There was a negative correlation between fruit volume and fruit size but it was not linear. In treatment D, lowest fruit number was observed, while fruit volume was the highest. In P2D1C1, regardless of high fruit number, fruit volume decreased. However, because of good vegetative growth, decrease in fruit volume was not significant.

The negative effect of date-peat on chlorophyll content and leaf number probably may be eliminated after composting. On the other hand, combination with cocopeat, perlite or both of them can reduce the adverse effect of non-composted date-peat. According to

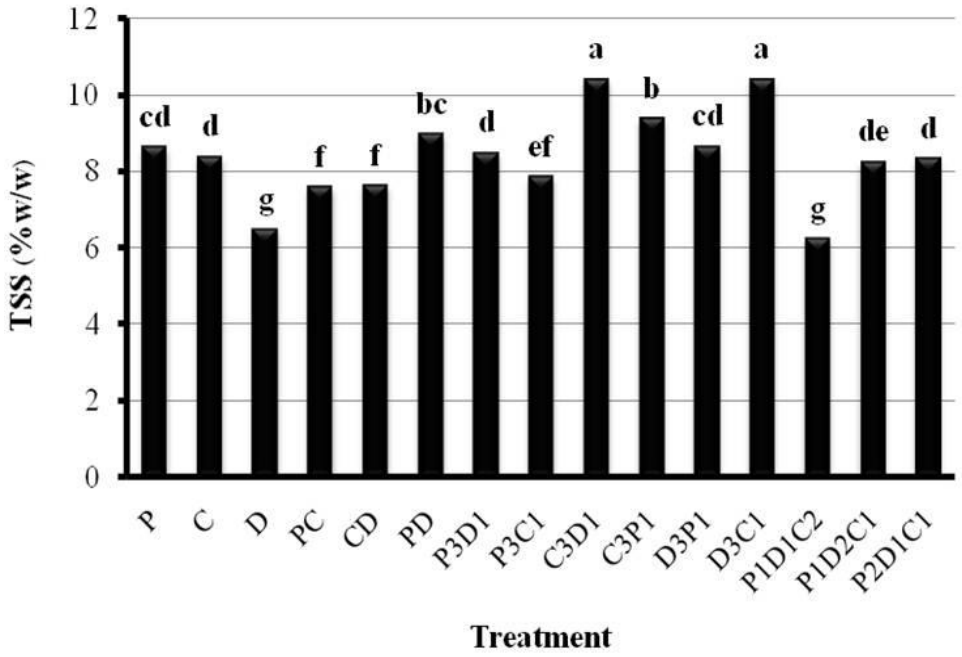

Figure 2. Effect of different combinations of culture media on rate of total soluble solid in hydroponic culture. (Means with similar letter are not significant at the 5% probability level).

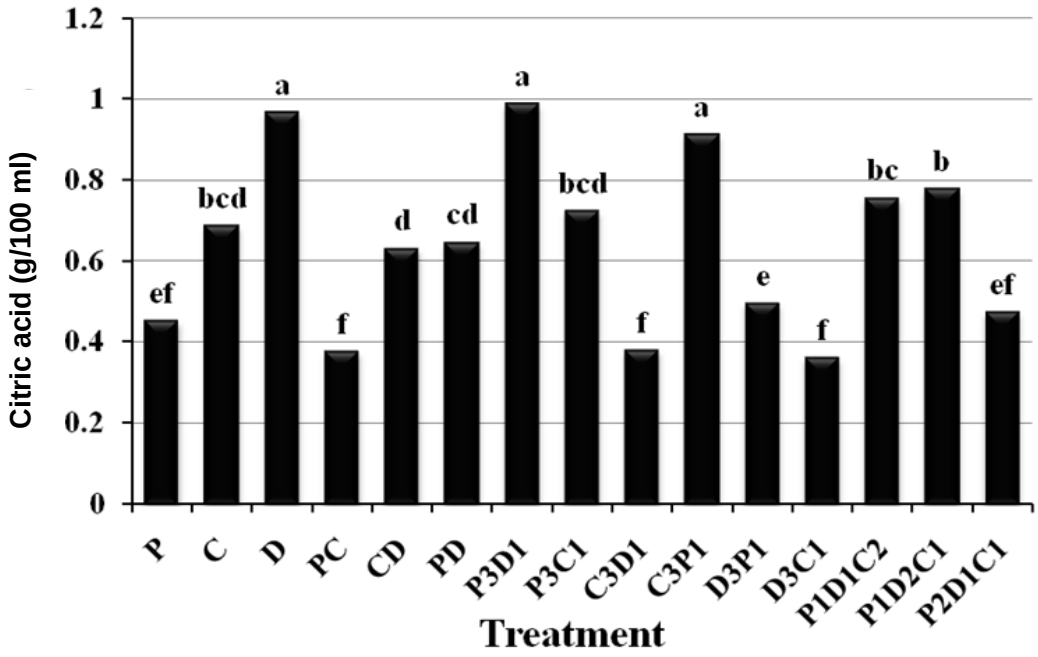

Figure 3. Effect of different combinations of culture media on fruit citric acid in hydroponic culture. (Means with similar letter are not significant at 5% probability level).

treatment P2D1C1, leaf number was the highest when data were compared with other treatments. High leaf number in treatment P (perlite) can be linked to negative correlation between high vegetative and non-vegetative growth. Effect of different culture media on fruit quality did not follow a specific pattern. In other words, the rate of soluble solids in fruit juice, vitamin C and acid content varied between media combinations; however, culture media with high organic matter content had better quality due to ratio of vegetative growth. As a matter of fact, high

energy consumption in treatments like P1C1 and P2D1C1 led to decreased TSS and vitamin C levels in fruit juice. In addition, acid contents were low in these treatments, which was as a result of fruit ripening. Acid content obviously, decreases in fruits as a result of fruit ripening.

Conclusion

The summary of the experiments shows that combination of organic matter as a moisture retainer, and perlite as a proper material for soil porosity in the growth media, results in higher yield and acceptable quality. Giving that plants growing in P1C1 and P2C1D1 media had the highest yield, moderate TSS in fruit juice and low acid content in this study. Since applied date-peat was not composted, it probably contained some inhibitory substances. Possibly, beforehand, composting could have decreased the negative effects of unknown substances when growing strawberries in hydroponic systems, and as so could have a potential as an appropriate material for full substitution of cocopeat.

REFERENCES

Abad M, Noguera P, Puchades R, Maquieira A, Noguera V (2002). Physico-chemical and chemical properties of some coconut coir dusts for use as a peat substitute for containerized ornamental plants. Bioresour. Technol., 82: 241–245.

Al-Raisy FS, Al-Said FA, Al-Rawahi MS, Khan IA, Al-Makhmari SM, Mumtaz Khan M (2010). Effects of column sizes and media on yield and fruit quality of strawberry under hydroponic vertical system. Eur. J. Sci. Res., 43: 48-60.

Arzani K, Lawes GS, Wood DES (1999). Estimation of `Sundrop' apricot fruit volume and fresh weight from fruit diameter. Acta Horticult., 488: 321-326.

Cantliffe DJ, Castellanos JZ, Paranjpe AV (2007). Yield and quality of greenhouse-grown strawberries as affected by nitrogen level in Coco Coir and Pine Bark Media. Proceed. Flo. State Horticult. Soc., 120: 157-161.

Caso C, Chang M, Rodríguez-Delfín A (2009). Effect of the growing media on the strawberry production in column system. Acta Horticult., 84: 373-380.

Dinar M (2003). Strawberry production in greenhouse. Proceeding of the International Congress Greenhouse, Puerto Vallarta, Jalisco, Mexico.

FAO (2008). FAO statistical yearbook. agricultural production. Food and Agriculture Organization of the United Nations (http://faostat.fao.org/site /339/default.aspx).

Fornes F, Belda RM, Abad M, Noguera P, Puchades R, Maquieira A, Noguera V (2003). The microstructure of coconut coir dusts for use as alternatives to peat in soilless growing media. Aust. J. Exp. Agric., 43: 1171–1179.

Gul A, Erogul D, Ongum AR (2005). Comparison of the use of zeolites and perlite as substrate for crisp-head lettuce. Sci. Hortic., 106: 464–471.

Hesami AA, Sarikhani Khorami S, Hosseini SS (2012). Effect of shoot pruning and flower thinning on quality and quantity of semi-determinate tomato (*Lycopersicon esculentum* Mill.). Notulae Sci. Biol., 4(1): 108-111.

Hoagland D, Arnon D (1950). The water-culture method for growing plants without soil. Circular 347.University of California, Berkeley, USA, p. 32.

Olympios CM (1993). Soilless media under protected cultivation Rockwool, Peat, Perlite and other substrates. Acta Horticult., 323: 215-234.

Paranjpe A, Cantliffe DJ, Lamb EM, Stoffella PJ, Powell C (2003). Increasing winter strawberry production in north-central Florida using passive ventilated greenhouse and high plant densities. Acta Horticult., 626: 269–276.

Rouphael Y, Colla G, Battistellia A, Moscatello S, Proitti S, Rea E (2004). Yield, water requirement, nutrient uptake and fruit quality of Zucchini squash grow in soil and closed soilless culture. J. Horticult. Sci. Biotechnol., 79: 422-430.

Tabatabaei SJ, Fatemi LS, Fallahi E (2006). Effect of ammonium, nitrate ratio on yield, calcium concentration and photosynthesis rate in strawberry. .J. Plant Nutri., 29: 1273-1285.

Tehranifar A, Poostchi M, Arooei H, Nematti H (2007). Effects of seven substrates on qualitative and quantitave characteristics of three Strawberry cultivars under soilless culture. Acta Horticultural. 761: 485-488.

Tehranifar A, Sarsaefi M (2002). Strawberry growing in Iran. Acta Horticult., 567: 547-549.

Tilt KM, Bilderback TE (1983). Manipulation of physical properties of pine bark and hardwood bark container media and its effects on the growth of three ornamental specie. Horticult. Sci., 18: 602–602.