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Full Length Research Paper

Effect of some culture substrates (date-palm peat, cocopeat and perlite) on some growing indices and nutrient elements uptake in greenhouse tomato

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In recent years, a wide range of soilless culture techniques have been developed and commercially introduced for intensive production of horticultural crops, particularly in greenhouses. Reasons for replacing soils as growing media arise from plant protection problems with soil-borne pathogens and environmental regulations against groundwater pollution with nitrate and pesticides. The aim of this study was to compare some growing indexes of greenhouse tomato that were cultivated in some substrates, such as perlite, date-palm peat and coco peat. The research was conducted in a completely randomized design with 6 replications. The treatments were coco peat + perlite (v/v=50%), date-palm peat + perlite (v/v=50%), perlite (100%) and date-palm peat(100%). Papadopolus formula was used for nutrient solution during plant growth with fertigation method. Also temperature, humidity and irrigation rate was constant for all treatments. Comparison of means showed that the media had no significant effect on concentration of nutrient elements in fruit such as N, P, K and yield in all treatments. Minimum and maximum amount of fruits yield was in date-palm peat and perlite treatments respectively. That had no significant difference with other treatments. Higher amount of total soluble solids (TSS) related to coco peat + perlite treatment that has not any significant difference with date-palm peat + perlite, perlite and date-palm peat treatments. Also, culture substrates had no significant difference on the amount of ascorbic acid. The results showed that date-palm peat is an appropriate media for soilless culture with suitable physical and chemical properties, availability and low cost. Therefore, it can be a new substrate that is introduced for replacing other media.

Key word: Soilless, substrate, date-palm peat, total soluble solids, ascorbic acid.

INTRODUCTION

In recent years, some problems in soil culture (such as salinity and unsuitable soil characteristics) and limitation of water resources in many countries, especially in Iran, causes the expansion of soilless culture. Soilless culture is an artificial means of providing plants with support and a reservoir for nutrients and water. The simplest and oldest method for soilless culture is a vessel of water in which inorganic chemicals are dissolved to supply all of the nutrients that plants require. Often called “solution culture or water culture”, the method was originally termed “hydroponics” (that is, "water working") by Gericke in the 1929s. Over the years, hydroponics has been used sporadically throughout the world as a commercial means of growing both food and ornamental plants. In recent years a wide range of soilless culture techniques have been developed and commercially introduced for intensive production of horticultural crops, particularly in greenhouses. Reasons for replacing soils as growing media arise from plant protection problems with soil-borne pathogens and environmental regulations against groundwater pollution with nitrate and pesticides. The use

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of soil in protected agriculture is facing many limitations in this country. After years of cultivation, deterioration in soil fertility and increase in soil salinity, in addition to the incurrence of soil-borne diseases and limited productivity of crops, have often been observed.

Therefore, utilizing substrate-based agriculture is a logical alternative to the current soil-based production approach in the country. The use of different organic and inorganic substrates allows the plants the best nutrient uptake and sufficient growth and development to optimize water and oxygen holding (Verdonck et al., 1982) . However, different substrates have several materials which could have direct and/or indirect effects on plant growth and development. Therefore selecting the best substrate between the various materials is imperative to plant productivity. The difficulty and cost of controlling soil born pests and diseases, soil salinity, lack of fertile soil, water shortage, lack of space and etc., have led to the development of substrates for soilless cultivation (Olympious, 1992). The properties of different materials used as growing media exhibit direct and indirect effects on plant growth and productivity. Some technical and economic factors play a role when choosing substrates. At the beginning gravel or sand, later materials such as peat, vermiculite, perlite have been used commonly. Today, in many countries, soilless culture techniques are used for production especially in greenhouses (Celikel, 1999). Fascella and Zizzo (2005) evaluated the influence of perlite and perlite mixed with coconut coir dust (coco peat) with 1:1 ratio (v/v) on quantitative and qualitative parameters of cut flower (cv. Anastasia) production, they reported that the mix caused the highest amount of flowers (17.7 stems/plant) and the longest stems (65 cm). Tehranifar et al. (2007) reported that the vegetative growth of a number of strawberry cultivars were higher in media with peat and coco peat compared with 100% sand and perlite and in coco peat 40% + perlite 60% some cultivars produced the highest number of fruits and yield per plant. The yield in substrates with peat or coco peat was higher than in substrates with without peat or coco peat.

Comparison of some indexes for tomato in the substrates include perlite and mixtures of perlite and zeolite in 1:1, 2:1 and 1:2 ratios showed that in the substrate with 2:1 ratio increased yield, soluble solids content and quality of tomato. Zeolite due to high cation exchange capacity (CEC), capacity to hold water and nutrient lead to improved yield and fruit quality (Djedidi et al., 1997). Gerbera that cultured in soilless method gave higher yield in perlite/zeolite (P/Z 1:1 ratio) substrate than other mixtures, due to sufficient aeration and improved water retention capacity (Issa et al., 1997). Turhan and Atilla (2004) studied the effect of perlite alone and mixture of P/Z (1:1 ratio) on ionic composition in "camarosa" strawberry plantlets during vegetative phase. They found that using perlite and zeolite (P/Z) mixtures as substrate to grow strawberry may be beneficial. Permuzic et al. (1998) showed that the quality and quantity of tomato fruit in the organic media is better than inorganic media.

For the tomato plant that was cultured in the different substrates, it was shown that the highest amount of total yield and numerous fruit was related to perlite + rice hull and the highest amount of total soluble solids (TSS) was related to coco peat substrate (Inden and Torres, 2004).

Effect of combination of some substrates such as perlite and compost with soil for tomato plant studied by Javanpour et al. (2005), their result showed that quality and quantity of tomato in the different substrates that used soil treatment had not any significant differences. In the other study on tomato plant, with perlite and lica substrates, it was shown that the highest yield and average weight of fruit was related to lica media (Shahinrokhsar et al., 2007). Effects of different substrates on growth, yield and quality of Watermelon that grow in soilless culture was studied by Yetisir et al. (2006), they showed that the highest vegetative growth was observed in the basaltic mix, sand, peat and soil substrates respectively. The weakest growth occurred in the mix of andesitic tuff and peat, while the highest and lowest yield was obtained from perlite and andesitic tuff, mix of basaltic tuff substrates respectively.

Quality and quantity of watermelon fruit had not any significant difference between different substrates. In the other study tomato plants were cultivated in five substrates (rockwool, perlite, and mixtures of perlite to zeolite 1:1, 1:2 and 2:1) with an open system and observed that highest yield performance was obtained by the mixture of perlite and zeolite with 1:1 ratio and highest flowering was obtained by perlite substrate. The tomato plants that grow in perlite and zeolite with 2:1 ratio had best distribution of fruit size, total soluble solid and sensorial quality and so highest dry matter of fruit was found in perlite substrate (Djedidi et al., 2001). Effect of the substrate on yield and fruit quality of tomato in soilless culture studied by Tzortzakis and Economakis (2008) showed that plants grown in pumice and perlite substrates obtained lower total yield; and higher yield was obtained from maize substrate. Pumice + 50% maize and 100% maize produced higher total number of fruits per plant. Fruit quality parameters such as mean of fruit weight, fruit firmness, total soluble solid, titrable acidity, ascorbic acid and carotenoids were influenced by substrates, while they had not any effect on EC, pH and dry matter content. The results suggested that addition of maize to perlite and pumice could improve the properties of inorganic substrates for tomato soilless culture, leading to higher yields and better fruit quality. Increase in ammonium nitrogen to the nutrient solution can reduce the amount of total soluble solid, titrable acidity and ascorbic acid fruits (Javanpour et al., 2005).

Samiei et al. (2005) investigated the effect of peat moss, coco peat and date-palm wastes as substrates on growing of Aglaonema and their results showed that leaf area, dry and wet weight of plant biomass, stool shoots

Table 1. Some physicochemical properties of different substrates.

Substrates	C/N (%)	BD (g/cm^3)	pH	EC (ds/m)	CEC (Cmol/kg)	Porosity (%)	WHC (%)	N (mg/L)	P (mg/L)	K (mg/L)
Coco peat	48.47	0.16	6.7	2.9	138.7	58	90.5	1.96	1.32	477.7
Perlite	0.0	0.13	7.8	1.6	0.0	68	96.7	0.27	0.57	0.1
Date- palm Peat	63.57	0.16	6.5	2.3	95.3	91	78.3	1.4	1.5	557.3

Definitions: WHC = Water Hold Capacity, BD = Bulk Density.

and length of meiophylly in plants cultured in peat moss and date-palm peat substrates was similar but this indexes for coco peat substrate was higher. Their results showed some characteristics such as CEC, pH, EC and organic carbon in peat moss and date-palm peat substrates were similar but water holding capacity in peat moss was higher than date-palm peat. They proposed if these characteristics of date-palm peat improve, it would be a proper substitute in the future. Date-palm extensively exist in the world and Iran and produce a lot of residues and wastes per annum. Unfortunately, there is no appropriate management and optimization procurement presently for adequate usage of this material. Although it seems that residues and wastes of date-palm can used as a substrate in greenhouse cultivation. The objective of this study was comparison of some growing indexes of tomato cultured in the perlite, date- palm peat and coco peat substrates and finally find answer to this question that “can we use date-palm peat as a substrate in soilless culture? “.

MATERIALS AND METHODS

This study has done in a period of seven months in soilless culture in the greenhouse of Islamic Azad University of Khorasgan in Iran. Plants cultured in bag with 105×30 cm dimensions and 42 L capacity that was appropriate for 2 tomato plants. The experiment was conducted in a randomized completely design with 4 treatments and 6 replications.

Average temperature of day and night were 30 and 18°C respectively. During plant growth, irrigation rate, temperature, humidity and pest control for all treatments were similar. During plant growth Papadopolus formula (1991, 1994) with fertigation method was used for nutrient solution. In this study coco peat, perlite and date-palm media as substrates were used. At first date-palm waste collected, clean and crushed. The treatments included coco peat + perlite (v/v=50%), date-palm peat + perlite (v/v=50%), perlite (100%) and date-palm peat(100%). Bulk density (BD), porosity and water holding capacity (WHC) of substrates were measured by Verdonck and Gabriels (1992) methods.

pH and electrical conductivity (EC) was measured in verdonck (1998) method. Nitrogen was analyzed by Kjeldahal method and carbon was measured with walkly-black methods, also phosphorus and potassium was measured by Olsen (1982) and Kudsen et al. (1982) methods respectively. Available nitrogen, phosphorus and potassium in substrates reported in mg per liter of substrates. Some physiochemical properties of the media are showed in Table 1. Some characteristics of fruits include total soluble solid (TSS) and ascorbic acid (vitamin C) content were measured. Ascorbic acid in tomato juice was determined by (AOAC) method. Total fruit weight of plant was measured with a digital scale. Data were analyzed with SPSS and comparison of means was determined by Duncan system.

RESULTS AND DISCUSSION

Some physicochemical properties of different substrates are presented in Table 1. Most of the amounts of EC, CEC, carbon/nitrogen (C/N) ratio and WHC were related to coco peat and date-palm substrates, respectively, while the highest amount of porosity was related to date-palm substrate, but perlite had the lowest amount of C/N ratio, BD, EC and CEC. Most concentrations of nitrogen were related to coco peat, while concentrations of phosphorus and potassium in date-palm were more than the other substrates. However, the lowest concentration of N. P and K is related to perlite substrate. Coco peat and date-palm are organic substrates in the composting process that caused the mineralization of organic matter and changed the organic forms of N and P to mineral forms. The available K in organic substrates, related to chemical characteristics of this media, is very high (Michael Ravin and et al 2008).

Comparison of means showed that yield of fruits had no significant difference between treatments at 5% level (Table 2). Highest amount of fruit yield related to perlite treatment (3.94 kg) had no significant difference with date-palm peat + perlite (3.8 kg), coco peat+ perlite (3.24 kg) and date-palm peat (3.19 kg) treatments. The plant, used for more production of fruits and sufficient growth, requires suitable physical and chemical conditions in substrates such as porosity, storage capacity, ventilation, CEC, pH, EC etc.

The results of this study showed that coco peat and date-palm peat media have higher amount of water holding capacity than perlite media that causes decrease of oxygen in ryzospher, but it seems that a high amount of porosity in date- palm

Table 2. Amount of TSS, vitamin C, fruit yield and some nutrient elements (N, P, K) in tomato fruit in different substrates.

Treatment	TSS (^{0}B)	Vit-C (%)	N (%)	P (%)	K (%)	Fruit yield (kg)
Coc peat+perlite	6.54a	15.4a	1.35a	1.06a	2.79a	3.24a
Palmpeat+perlite	6.12a	14a	1.12a	1.03a	3.32a	3.8a
Perlite	6.37a	17a	1.07a	1.2a	2.17a	3.94a
Palm peat	5.2a	17.4a	1.19a	2.06a	3.21a	3.19a

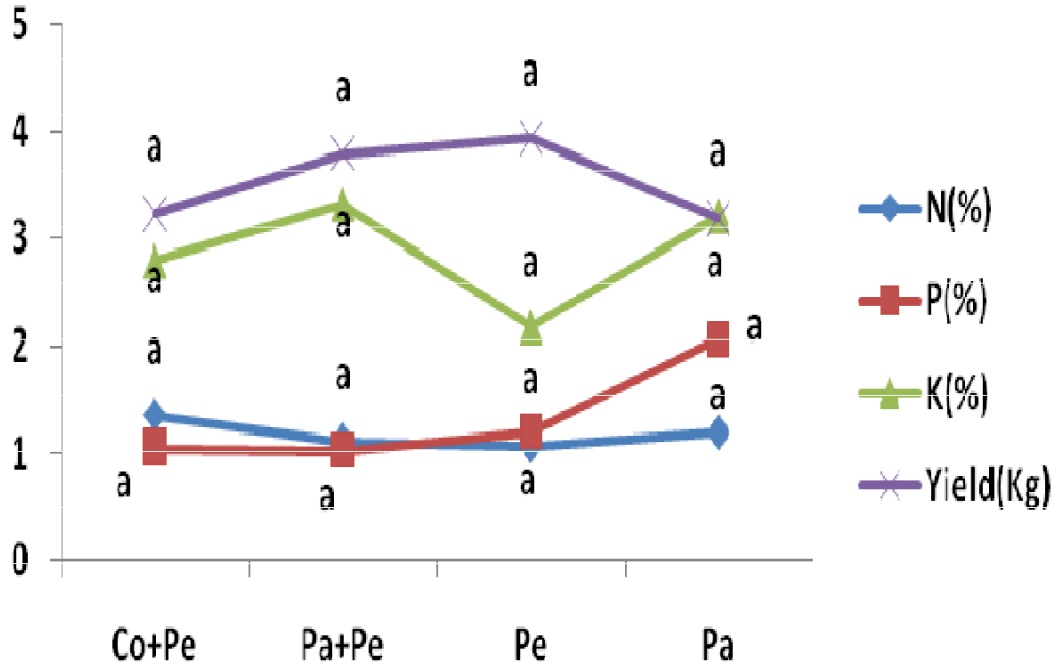

Figure 1. The effects of culture substrate on concentration of N, P and K in tomato fruit.
Definitions: Co = Cocopeat , Pe = Perlite, Pa= Palm Peat

peat controlled this problem.

Generally, coco peat and palm peat media with aspect to physiochemical characteristics had no significant difference (Samiei et al., 2005) thus no significant difference was obtained between these substrates in fruit yield. Coco peat has been recognized to have a high water holding capacity which causes poor air-water relationship, leading to low aeration within the medium, which affected oxygen diffusion to the roots (Abad et al., 2002).

The substrates had no significant difference at 5% level in concentration of nitrogen, phosphorus and potassium in fruits (Table 2). The highest and lowest concentrations of fruit nitrogen are related to coco peat + perlite and perlite treatments, respectively and the highest concentration of fruit phosphorus is related to date- palm peat treatment, but the concentration of potassium in tomato fruit was less in Perlite treatment than other treatments, because concentration of nitrogen, phosphorus and potassium in Coco peat and Date-palm peat was more than Perlite Figure 1. Available potassium in coco peat and date palm peat substrates were very high as compared to perlite but concentration of potassium in fruit had no significant difference in all substrates. Although availability of nutrient elements (N, P and K) and their buffer capacity in organic substrates were very high as compared to perlite but they had no important effect on uptake of this elements by plants because concentration of this nutrient elements in solution in Papadopolus formula were high (N=201-238, P=62 and K=370-390 ppm) . Alifar et al. (2010) showed that substrates including peat, coco peat and perlite had no significant difference on concentration of nitrogen, phosphors and potassium in cucumber fruit. The results of Saberi et al. (2006) showed that substrates) mica, rice hull, coco peat, perlite and zeolite) had no significant difference on concentration of phosphorus in fruit.

The substrates had no significant difference on TSS of fruit at 5% level. The maximum and minimum amount of TSS are related to coco peat + perlite (6.54°B) and

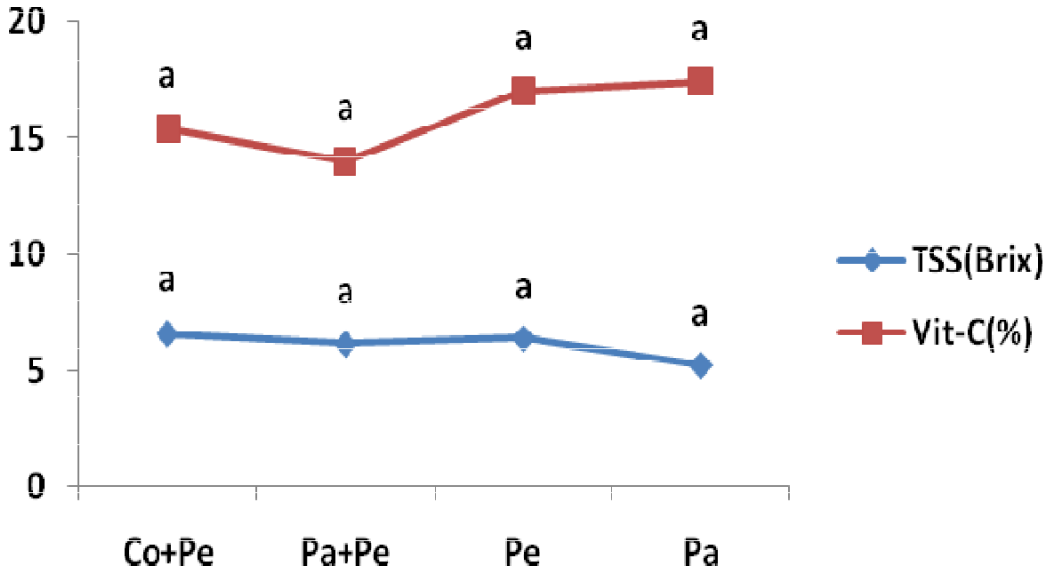

Figure 2. The effect of culture substrate on amount of Vit-C (%), TSS (B0) and fruit yield (kg) of tomato.

date- palm peat (5.2) treatments, respectively. This result was similar to Inden and Torres (2004) results.

High concentrations of ammonium in nutrient solution can reduce TSS and so increase in macro elements concentration resulted in increase of TSS of tomato fruits (Javanpour et al., 2005) but in this study combination of nutrient solution for all treatments was constant and N, P and K concentration in Papadopolus formula were rich and it showed that difference in available macro elements and CEC had no significant effects on TSS in different substrates. Higher amount of sugar and organic acid content improves the quality of tomato fruits.

Islam et al. (2002) reported that the amount of TSS in tomato juice have no significant differences in organic and inorganic substrates (carbonated rice hull, coir, rock wool).

The amount of ascorbic acid (vitamin C) in tomato fruits in different treatments had not any significant difference at 5% level. The highest amount of vitamin C related to date-palm peat (17.4%) treatment and lowest amount of vitamin C was related to date-palm peat + perlite (14%) treatment (Figure 2). Padem and Alan (1994) and Islam et al. (2002) reported that different substrates (carbonated rice hull, coir, rock wool) had no significant differences in ascorbic acid content in fruit of pepper and tomato that were hydroponically grown and their results agree with the present study.

Conclusions

Results of last investigations showed that coco peat and perlite were sufficient substrates for growing of some plants, especially for vegetables. Thus, growers use these materials as growing media in greenhouses. Also, results of this investigation indicated that coco peat and date- palm peat media had similar properties and they have not created any significant difference on qualitative and quantitative indexes in tomato fruit.

Thus, considering the low cost, availability and abundance of date-palm cultivation in Iran (242000 ha), it seems that date palm wastes can be replaced with coco peat media for growing of certain vegetables in Iran.

In order to reduce cost of using imported expensive organic materials to be used in growing media in protected production, it is recommended that this study is extended to a wide range of plant species with even higher ratios of date-palm peat in the growing media.

REFERENCES

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

Alifar N, Mohammadi Ghehsareh A, Honarjoo N (2010). The Effect of growth media on cucumber yield and its uptake of some nutrient elements in soilless culture. J. Sci. Technol. Greenhouse Culture. Isfahan Univ. Technol., 1: 19-25.

Celikel G (1999). Effect of different substrates on yield and quality of tomato. Acta Hortic., 486: 353-357.

Djedidi M, Grasopoulos D, Maloupa E (1997). The effect of different substrates on the quality of F. Carmello tomatoes (*Lycopersicon escullentum* MILL) grown under protection in a hydroponic system. Chaiers Options Mediterranean's, 31: 379 – 383.

Djedidi M, Gerasopoulos D, Maloupa E (2001). The effect of different substrates on the quality of F. Carmello tomatoes grown under protection in a hydroponics system. Cahiers Option Mediterranean's., p. 31.

Fascella G, Zizzo GV (2005). Effect of Growing Media on Yield and Quality of Soilless Cultivated Rose. Acta Hortic. (ISHS), 697: 133-138.

Gericke WF (1929). Aquaculture, a means of crop production. Am. J. Bot., 16: 862.

Islam S, Khan S, Ito T, Maruo T, Shinohara Y (2002). Characterization of the physico-chemical properties of environmentally friendly organic substrates in relation to rockwool. J. Hortic. Sci. Biotechnol., 72: 143 –148.

Issa M, Maloupa E, Gerasopoulos D (1997). Effects of the substrate on yield and quality of two gerbera vareteis grown under protection. Chaiers Options Mediterranean's*.,* 31: 365 – 369.

Inden H, Torres A (2004). Comparison of four substrates on the growth and quality of tomatoes. Acta Hortic. (ISHS), 644:205-210.

Javanpour R, Babalar M, Kashi AAbdolbaghi M, Asgari MA (2005). Effecta of types nutrient solutions and media on quantitative and qualitative characteristics of greenhouse tomato (Hamra') in hydroponic system. J. Agric. Sci., Iran. (in Persian). 36(2): 503-510.

Kudsen D, Peterson GA (1982). Methods of soil analysis.m Part2: Chemical and microbiological propertirs(2nd ed). lithium sodium and potassium. Miller, R Kenny. pp. 225-245.

Michael Ravin, Heinrich Lieth J (2008). Soilless culture: Theory and Practice. Elsevier. p. 571.

Olympious CM (1992). Soilless media under protected cultivation rockwool, peat, perlite and other substrates. Acta Hortic., 401: 443-451.

Padem H, Alan R (1994). The effect of some substrates on yield and chemical composition of pepper under greenhouse conditions. Acta Hortic., 366: 445–451.

Papadopolus AD (1991). Growing greenhouse tomatoes in soil and soilless. Communication Branch, Agriculture Canada. Ottawa. p. 79.

Papadopolos AP (1994). Growing Greenhouse Cucumbers in Soil and in Soilless Media., p. 108.

Permuzic Z, Bargiela M, Garci A, Rendina A (1998). Calsium, iron, potassium, phosphorous and vitamin C content of organic and hydroponic tomatoes. Hortic, Sci., 33(2): 255-257.

Saberi Z, Khoshgoftarmanesh AH, Kalbasi M, Mobli M (2006). Usage of Zeolite, Mica and some neutral materials as substrates for tomato cultured in hydroponic method. MS thesis, Isfahan University of Technology. p. 116.

Samiei L, KHalighi A, Kafi M, Samavat S, Arghavani M (2005). An investigation of substitution of peat moss with palm tree celluloid wastes in growing aglaonema (Aglaonema Commutatum Cv. Silver Queen). Iranian J. Agric. Sci., (in Persian). 36(2): 503-510.

Shahinrokhsar P, Davari K, Peyvast GH, GHahraman B, Nemati H (2007). Influence of irrigation interval and substrates on production of tomato (cv.hamra) in soilless (bag) culture. J. Agric. Eng. Res., 8(1): 31- 46. (in Persian).

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

Tzortzakis N, Economakis GCD (2008). Impacts of the substrate medium on tomato yield and fruit quality. Hortic. Cult. Sci., 2: 83-89.

Turhan E, Atilla E (2004). Effect of chloride application and different growth media on Ionic composition in strawberry plant. J. Pl. Nutr., 27: 1653 – 1665.

Verdonck O, Vleeschauwer D, De Boodt M (1982). The influence of the substrate to plant growth. Acta Hortic. (ISHS), 126: 251-258.

Yetisir H, Sari N, Aktas H, Karaman C, Abak K (2006). Effect of different substrates on plant growth yield and quality of watermelon grown in soilless culture. Agric. Environ. Sci., 1(2): 113-118.