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Effect of date-palm and perlite substrates on nutrients content and quality of tomato grown in soilless culture

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ABSTRACT

Use of suitable growing media in soilless culture or substrate high quality is essential for production of crops. The aim of this study was to find out the effects of culture substrates on tomato fruit nutrient (N and K) and fruit quality in soilless cultivation. This study was conducted in the greenhouse of Islamic Azad University of Khorasgan in Iran. The experiment was conducted in a randomized design with six replications. Treatments were date-palm peat 1 (without fermentation period), perlite, palm peat 2 (with three months fermentation period) (v/v=100%), perlite+date-palm peat 2 (v/v=50%) and perlite+date-palm peat 1 (v/v=50%). Maximum total soluble solids (TSS), related to perlite treatment had non-significant difference with other treatments. Also media had no significant effect on nitrogon in fruit. The aspect of titrable acidity (TA), potassium and TSS/TA had not any significant difference between treatments. The results showed that palm peat with suitable physical properties, availability, low cost and efficiency of palm cultivated could be a new substrate that was introduced for replacing with other media.

Key words : Nutrients, palm peat, soilless, titrable acidity, tomato, total soluble solids

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, caused to expand soilless culture. Soilless culture is an artificial means of providing plants with support and a reservoir for nutrients and water. Kanazirska *et al.* (1997) 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. Moreover, some growers prefer the soilless production on purpose due to high yield and good quality of crops. Soilless cultivation serves to improve better control of the growing medium and to avoid any likely problems for watering and maintaining proper nutrient concentrations. Good control of the plant growth and development in soilless cultivation of vegetables give proportionally higher yield and better quality crops compared to traditional greenhouse production in soil. This technique is mainly practised with substrate medium. This is due to superior physical and chemical properties of the substrates and their initial low infestation rate with pathogenic pest and due to their ease of disinfestation. Frequent irrigation and continued fertilization should satisfy nutritional plant demands under most practical situations (Raviv *et al.,* 2002).

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 soilborn pests and diseases, soil salinity, lack of fertile soil, water shortage, lack of space, etc. have led to the development of substrates for soilless cultivation (Olympious, 1992). Effect of combination of some substrates such as perlite and compost with soil for tomato plant was

studied by Javanpour *et al.* (2005). Their results showed that quality and quantity of tomato in the different substrates that used soil treatment had not any significant differences.

Perlite culture is one of the most efficient and a cost-effective methods of soilless cultures due to its relatively low construction cost, simplicity of operation, ease of maintenance and service. However, perlite culture requires sterilization between crops and feed lines may be blocked with perlite particles, in addition to rapid salt build-up (Wright, 1992).

Effects of different substrates on growth, yield and quality of watermelon that grows in soilless culture were studied by Yetisir *et al.* (2009) and they showed that 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 and mix of basaltic tuff substrates, respectively. Quality and quantity of watermelon fruit had not any significant difference between different substrates.

Samiei *et al.* (2005) investigated effect of peat moss and date-palm wastes as substrates on growing of Aglaonema and their results showed that peat moss and date-palm peat were similar in some characteristics such as CEC, pH, EC and organic carbon but water holding capacity in peat moss was higher than date-palm peat. If this characteristic of date-palm peat improves, it would be a proper substitute in the future date-palm extensively existing in the world and Iran and produce a lot of residues and wastes per annum. Currently, appropriate management and optimized procure is not to use this material now. It seems that residues and wastes of date-palm can be used as a substrate in greenhouse cultivation and, therefore, it decreases problem of date-palm owners. The objective of this study was to study the effects of date-palm and perlite substrates on nutrition and quality of tomato in soilless culture.

MATERIALS AND METHODS

This study was conducted in a period of seven months in soilless culture in the greenhouse of Islamic Azad University of Khorasgan in Iran 2010. Plants were cultured in bag with 105 × 30 cm dimensions and 42 l capacity that was appropriate for two tomato plants. The experiment was conducted in a randomized completely design with five treatments and six replications. Average temperature of day and night was 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 with fertigation method was used for nutrient solution. The treatments included date-palm peat 1 (whithout fermentation period), date-palm peat 2 (with three months fermentation period), perlite, perlite+date-palm peat 2 (v/v=50%) and perlite+date-palm peat 1 (v/v=50%).

Laboratory Analysis

Tomato fruits were harvested and brought to the laboratory for biochemical analyses to estimate TSS, TA and TSS/TA of the juice, also number of fruits and number of flowers. Total soluble solids (TSS) were estimated by refractometer, vit. C and titratable acidity (TA) and were measured by titration according to the A. O. A. C. Ionic concentrations of N, P, K, Fe and Mn were determined for the dry matter of fruits. Total per cent nitrogen was determined by the Kjeldahl method and phosphorus determined by Olson method. The levels of other nutrients in the extraction of K, Fe and Mn were determined by the atomic absorption spectrometry (Perkin Elmer, Model AAS 3110). Statistical analysis was performed using MSTAT-C ($P<0.05$) with Duncan for means' comparison.

RESULTS AND DISCUSSION

Effect of Substrate on Quality of Fruits

Number of fruits had not any significant difference between treatments (Table 1). Maximum number of fruits related to perlite treatment and minimum number of fruits related to palm peat 2+perlite treatment. This result may be related to better aeration that affects root oxygen.

The substrates had significant difference on TSS of fruit at 5% level (Table 1). This result may be due to high concentration of nutrient in substrate palm peat 2+perlite.

Table 1. Comparison means of quality and quantity in tomato fruit

Substrate	TSS	TA	TSS/TA	No. of fruits	Flower traces	No. of flowers/ trace
Perlite	6.37b	1.05a	6.06a	70a	8.1b	88.1a
Palm peat 2	6.25ab	1.26a	4.96ab	67a	9.8b	85.1a
Palm peat 1	5.37b	1.38a	3.89b	62a	8.1b	77.3a
Palm peat 1+Perlite	6.12ab	0.89a	6.87a	66a	16.7a	81.6a
Palm peat 2+Perlite	7a	1.3a	5.38ab	61a	10 b	73.8a

Different letters in columns show significant difference based on Duncan's multiple test at P≥0.05.

Increasing concentrations of macro elements resulted in increased soluble solids of tomato fruits (Lee *et al.,* 1999).

High concentrations of ammonium in solution could reduce TSS and increase in macro elements concentration resulted in increase in TSS of tomato fruits (Javanpour *et al.,* 2005). Islam *et al.* (2002) reported that amount of TSS in tomato juice had no significant differences in organic and inorganic substrates.

Comparison of means showed that total acidity and number of flower traces had no any significant difference between treatments (Table 1). The pH in juice fruits had effect on total acidity (TA). The low level of potassium had effect on quality of tomato and therefore had effect on total acidity and reduced fruit quality (Mazumdar and Majumdar, 2003).

TSS/TA showed significant difference in 5% level. Maximum ratio was related to palm peat 1+perlite (6.87). Considering the ratio, TSS/TA had an expression of fruit sweetness.

Concentration of Nutrients in Fruits

Substrate had no any significant difference in nitrogen and potassium in fruits. Maximum N (%) was related to palm peat 2+perlite (1.26) treatment and maximum concentration of potassium (%) was related to palm peat 1+perlite (3.3) treatment. These results were related to concentration of nutrition in substrate.

Comparison of means showed significant difference in P, Fe and Mn (%) fruits (Table 2). These results may be related to high concentration of calcium and magnesium in substrate that affects absorption of phosphorus in fruits. Alifar *et al.* (2010) showed that substrates including peat, cocopeat and perlite had no any significant difference in concentration of nitrogen, phosphorus and potassium in cucumber fruits. The results of Saberi (2009) showed that substrates (mica, rice hull, cocopeat, perlite and zeolite) had no significant difference in concentration of phosphorus in fruits.

The substrates had significant difference at 5% level in amount of Fe (%) in fruits (Table 2). Maximum amount of Fe was related to palm peat 1+perlite (14.57) that may be due to high concetration of Fe in palm peat 1 and perlite (Table 3).

Table 2. Comparison means of concentration nutrient in tomato fruit

Treatment	N (%)	P (%)	K (%)	Fe (%)	Mn (%)
Palm peat 1	1.19a	2.04a	3.2a	13.14a	17.2ab
Palm peat 2	0.84a	0.54c	2.9a	13.14a	18.2ab
Perlite	1.07a	1.19ab	2.16a	11.22b	19.12a
Palm peat 1+Perlite	1.12a	0.38c	3.3a	14.57a	17.28ab
Palm peat 2+Perlite	1.26a	0.83b	3.04a	12.66ab	16.36ab

Different letters in columns show significant difference based on Duncan's multiple test at P≥0.05.

Table 3. Concentration of nutrition in substrate before cultivation

Substrate	$N\text{-}NO_3$	P	K	Mg	Ca	Fe	Cu	Mn	Zn
	mg/l								
Perlite	3.26	3.01	26.53	72.29	144.59	23.64	0.14	1.72	0.74
Palm peat 2	2.42	2.35	504.2	69.72	139.45	24.6	0.89	4.9	2.5
Palm peat 1	1.12	2.10	809.38	73.58	147.16	15.52	0.7	3.84	1.16

The substrates had significant difference at 5% level in amount of Mn (%) in fruits (Table 2). Maximum amount of Mn was related to perlite (19.12%). These results were related to low CEC in perlite media that affect absorption of Mn. Alifar *et al.* (2010) showed that substrates had no significant difference in Mn (%) in fruits.

CONCLUSION

In general, high similar properties of perlite and palm peat media were considered and had no any significant difference in quality and quantity of some index between palm peat and perlite media, low cost, availability, abundance palm peat cultivation in Iran (242000 ha). It seems that date-palm wastes can be situated with other media (perlite and cocopeat).

Results of this investigation indicated that the use of the date-palm peat waste (available ubiquitously in Iran) in higher proportions as a constituent of the growing media than other popular and relatively expensive organic and inorganic substrates such as cocopeat and perlite could provide promising alternative extremely, an inexpensive material for growing certain vegetable crops 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.

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