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The Effect of Particle Size and Composting Time of Date-Palm Waste as a Culture Media on Quality of Tomato

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ABSTRACT

The experiment was conducted as factorial in a completely randomized block design with 27 treatments and 4 replications under greenhouse conditions. Treatments included three sizes (S_1= <0.5, S_2= 0.5-1 and S_3=1-2 cm), three composting times (C_1=0, C_2=3 and C_3=6 months) of date palm waste and three irrigation levels (I_1 =60% I_3, I_2= 80% I_3 and I_3=100%). During cultivation, the Papadopolus formula was used as fertigation solution. K, EC, pH, TA and vitamin C in tomato fruits differed significantly depending on composting time, particle size and irrigation level ($P< 0.05$). The highest amounts of K, EC, pH, TA and vitamin C in tomato fruit indicated that culture media 6 months composted, size 0.5-1 cm and irrigation 100% increased quality parameters of tomato fruit more than the other treatments. The result of this research showed that the characteristics of the growing media, as well as the growing techniques used (fertigation and irrigation levels), determine the quality of the tomato fruits that were produced.

Key words: Date-Palm waste, Composting time, Particle size, Irrigation, Tomato

Introduction

Soilless culture as a crop production system has been used around the world. Using waste materials, most of them locally produced, as soilless growing media has been the subject of an important number of studies, especially as an alternative to peat for ornamental potted plants [14] and even for tomato transplant production [21]. Worldwide, 12% of the hydroponic industry uses organic media as substrate and/or as compost [8]. The properties of different material used as growing substrates exhibit direct and indirect effects on plant growth and production. The selection of a particular material depends on its availability, cost and local experience of its use. Date-palm extensively exist in the world and Iran and produce a lot of residues and wastes per annum [2]. Currently, appropriate management and optimize procure is not to use these material. Samiei *et al*. [23] investigated the 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 and date-palm waste can be replaced with peat moss substrates. Mohammadi *et al*. [19] and Borji *et al*. [4] showed that date-palm waste could be a media for soilless culture with suitable physical and chemical properties, available and low cost in compare to perlite and coco peat. The objective of this research was to study the effect of particle size and composting time of date-palm waste as a culture media on quality of tomato fruit.

Material And Methods

This study was performed in the greenhouse research site of Isfahan Azad University (Khorasgan) in Iran. The experiment was conducted as split factorial in a completely randomized block design with 27 treatments and 4 replications. Treatments included three sizes (S_1=<0.5, S_2=0.5-1 and S_3=1-2 cm), three composting times (C_1=0, C_2=3 and C_3=6 months) and three irrigation levels (I_1 =60% I_3, I_2= 80% I_3 and I_3=100%). Palm wastes were chopped, sieved and separated in three sizes (<0.5 cm, 0.5-1 cm, and 1-2 cm). Then, they were kept in 1.5 m^3 plastic bags for composting. Animal fertilizer (200 gram Cow manure), mineral N (450 gram Urea Fertilizer) and P (200 gram Superphosphate) were added to the wastes. For respiration, some air holes were made on the bags and the moisture was adjusted to 65%. Then, the processed palm wastes were used as culture media for tomato cultivation. Seeds of tomato (Izmir cultivar) were planted in cocopeat and

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transferred to 10 L pots filled with palm wastes. One plant was grown per replicate. Average temperature of day and night were 30 and 18°C respectively in greenhouse. During cultivation, irrigation was done by hand and Papadopolus [20 formula was used as fertigation solution. To determine the amount of irrigation water of treatment I_3, class A pan located inside the glasshouse was used [18]. Leaching of pots (culture media) were performed every fifteen days for prevention of salt accumulation in the pots. Some physiochemical characteristics of the culture media including bulk density and porosity [7], C/N ratio [3], water holding capacity (WHC) [25], cation exchange capacity (CEC) (Banijamali and Yosefbigi, 2005), electrical conductivity (EC) and pH [13] were measured. For measuring available K in date palm waste, samples were extracted by $CaCl_2$. 2 H_2O + DTPA then available potassium (K) [3] was determined. Table 1 shows average of some physicochemical properties of culture media with four replicates.

Table 1: Some physicochemical properties of culture media

Treatment composting time	Size	BD (g/cm^3)	Porosity (%)	WHC (%)	EC (ds/m)	pH -	CEC (Cmol/kg)	C/N (%)	K (ppm)
C_1S_1 = 0 month	<0.5 cm	0.25	83	89.65	6.29	6.84	38.85	37.88	5991.29
C_2S_1= 3 months	<0.5 cm	0.18	88	94.26	5.68	6.72	47.49	29.85	8289.47
C_3S_1= 6 months	<0.5 cm	0.19	87	92.62	5.99	6.91	59.11	25.43	8500
C_1S_2= 0 month	0.5-1 cm	0.17	89	57.5	3.91	6.74	28.84	40.83	5895.39
C_2S_2= 3 months	0.5-1 cm	0.18	88	74.57	4.42	6.62	36.26	33.56	7258.06
C_3S_2= 6 months	0.5-1 cm	0.19	87	58.91	4.62	6.86	38.3	28.2	7329.32
C_1S_3= 0 month	1-2 cm	0.15	90	37.75	3.41	6.69	18.22	43.67	5885.42
C_2S_3= 3 months	1-2 cm	0.16	89	53.48	3.8	6.54	28.99	30.76	7772.34
C_3S_3= 6 months	1-2 cm	0.17	88	59.31	4.97	6.82	34.95	23.68	9270.83

Definition: BD=bulk density, WHC=water holding capacity, EC=electrical conductivity, CEC=cation exchange capacity, C/N=carbon to nitrogen ratio, K= potassium

Total acidity (TA) and vitamin C (AOAC, 1975), K [11], EC and pH [5] of tomato fruits were determined. Experimental data normality was verified, and then data were submitted to analysis of variance, using SAS [24] software package. Means were compared using Duncan multiple test ($P< 0.05$).

Results And Discussion

Table 2 shows the effect of composting time, particle size, irrigation level of culture media and their interaction in relation to K, EC, pH, TA and vitamin C of tomato fruit. Statistical analysis indicated K, pH, TA and vitamin C of tomato fruit were significantly different at 5% level for different composting times. Nevertheless, no effect was found in EC. Research results revealed that culture media C_3 significantly ($P< 0.05$) resulted in higher K, pH, TA and vitamin C than other media. It could be due to maturity of compost. Forster *et al*. [9] reported the best definition for maturity of compost is applied concept of it with attention to plant response. In this research the best plant response to culture media was in six months composted according to quality of tomatoes. Maturity is associated with plant-growth potential and mature compost gives plants an advantage in increased nutrients and water availability, and reduces disease pressures [6,12]. Results showed K, EC, pH, TA and vitamin C in tomato fruits were significantly affected by size of culture media ($P< 0.05$). The highest K, EC, pH, TA and vitamin C were observed in culture media S_2. This result showed size 0.5-1 cm was a good growing media providing sufficient anchorage to the plant, served as reservoir for nutrients and water, allowing oxygen diffusion to the roots and permitting gaseous exchange between the roots and atmosphere outside the root of culture media in compare with the other sizes. Loehr [15] studied the effect of particle size of compost on mushroom and reported smaller particles (0.65 cm) were more suitable than larger particles for culture media. Statistical analysis illustrated K, EC, pH, TA and vitamin C in tomato fruit were significantly different at 5% level for different irrigation levels. The culture media with irrigation I_3 significantly ($P< 0.05$) resulted in higher K, EC, pH, TA and vitamin C than the other irrigation levels. Frequent irrigation and continued fertilization should satisfy nutritional plant demands under most practical situations [22]. Amounts of irrigation with nutrient solution affected on amounts of K absorption by plant because concentration of this nutrient element in Papadopolus formula was high (K=370-390 ppm) and the amount of fertilizer applied during plant growth was dependent on the irrigation treatment. Tomato is a high K requiring crop and fruit quality is directly affected by K supply [16]. The low level of K has effect on tomato quality and therefore affect on total acidity and reduction of fruit quality [17]. The pH in fruit juice was significantly affected by K applications, so that increased K levels resulted in higher total acidity (TA) content, vitamin C content, average fruit weight and pH of fruit juice [10]. Also a significant Composting time × Size interaction, Composting time × Irrigation interaction, Size × Irrigation interaction and Composting time × Size × Irrigation interaction ($P <0.05$) indicated that interaction among culture media 6 months composted, size 0.5-1 cm and irrigation 100% increased quality parameters of tomato fruit.

Table 2: The effects of different composting times, sizes and irrigation levels on K, EC, pH, TA and vitamin C in tomato fruits

Treatment	K (%)	EC (ds/m)	pH -	TA (nmol/l)	Vitamin C (%)
Composting time					
C_1=0 month	2.1[b]	4.1[a]	4.55[c]	46.28[c]	11.28[c]
C_2=3 months	2.12[b]	4.04[a]	4.59[b]	50.69[b]	14.64[b]
C_3=6 months	2.29[a]	4.08[a]	4.62[a]	56[a]	16.34[a]
Size fraction					
S_1=< 0.5 cm	2.12[b]	4.04[b]	4.57[b]	45.78[c]	13.16[c]
S_2=0.5-1 cm	2.24[a]	4.11[a]	4.61[a]	58.58[a]	14.92[a]
S_3=1-2 cm	2.14[b]	4.06[b]	4.58[b]	48.61[b]	14.14[b]
Irrigation					
I_1=60%	2.14[b]	3.92[b]	4.56[c]	45.95[c]	14.01[b]
I_2=80%	2.15[b]	4.15[a]	4.58[b]	50.59[b]	14.81[a]
I_3=100%	2.21[a]	4.13[a]	4.61[a]	56.45[a]	14.81[a]
Significance of main effects and mean separation values for interactions					
Composting time	*	NS	*	*	*
Size	*	*	*	*	*
Irrigation	*	*	*	*	*
Composting time × Size	*	*	*	NS	*
Composting time× Irrigation	*	NS	*	*	*
Size × Irrigation	*	*	NS	*	*
Composting time × Size × Irrigation	*	*	*	*	*

* Significant at the α= 0.05 probability level; NS = non significant

Conclusion:

Our results showed that size 0.5-1cm and 100% irrigation created the highest K, EC, pH, TA and vitamin C. Also culture media with 6 months composted illustrated the maximum K, pH, TA and vitamin C. The result of this research indicated that the characteristics of the growing media, as well as the growing techniques used (fertigation and irrigation levels), determine the quality of the tomato fruits that were produced**.** Nutrient elements content especially potassium content is important for the nutritional value of tomato. Overall results of this study showed that 6 months composting and size of 0.5-1 can be considered as a proper treatment for palm waste in soilless culture.

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