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THE EFFECT OF DATE-PALM WASTES AS A CULTURE MEDIA ON SOME NUTRIENT ELEMENTS OF TOMATO FRUIT

SUMMARY

In many countries, soilless culture techniques are used for production, especially in greenhouses. The experiment was conducted as split factorial in a completely randomized block design with 27 treatments and 4 replications. Treatments included three particle 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 amounts of irrigations (I_1 =1.8, I_2= 2.4 and I_3=3 liters). During tomato growth Papadopolus formula with fertigation method was used for nutrient solution. Highest amount of porosity and carbon/nitrogen ratio were related to culture media C_1S_3. Different irrigations, particle sizes and composting times of palm wastes had significant effect on N, P, K, Ca, Mg and Fe in tomato fruit ($p< 0.05$). Maximum concentration of N, P, K, Ca, Mg and Fe in tomato fruit were related to treatment $C_3S_2I_3$ ($p< 0.05$). The overall results of this research indicated culture media quality is one of the most important influences on fruit quality. A good culture media has both the chemical and physical properties that promote healthy of fruit. Nutrient elements content especially potassium content is important for the nutritional value of tomato. Iron and calcium plays an important role in tomato nutrition and fruit quality, they are essential for bone development and efficient oxygen carrier in blood system.

Keywords: composting time, date palm wastes, particle size, soilless culture, tomato.

INTRODUCTION

Tomato is one of the world's most important horticultural crops. Modern greenhouse production is driven by a requirement for high yields of fruit with very high quality and flavor, which are all essential for consumer satisfaction and the success of the industry (Grunert et al, 2008). In many countries, soilless culture techniques are used for production, especially in greenhouses (Çlikel, 1999). Various substitute materials have been tested to replace peat at least partly in growth substrates. Such substitute material can consist of bark and compost (Linderman and Davis 2003a; veeken et al, 2003). Date-palm (Phoenix dactylifera) extensively exist in the world and produce a lot of residues and

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wastes per annum (Barreveld 1993). Also date palm is one of the important productions in the gardens of Iran and there is no management for wastes of date palm. Mohamadi et al (2011) showed date palm waste could be a media for soilless culture with suitable physical and chemical properties, available and low cost. The objective of this research is the using of Date-Palm wastes as a culture media on some nutrient elements of tomato fruit.

MATERIAL AND METHODS

This research 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 particle 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 amounts of irrigation (I_1 =1.8, I_2= 2.4 and I_3=3 liters). Palm wastes were chopped into smaller sizes by combine and chopped wastes are separated in three sizes (<0.5, 0.5-1 and 1-2 cm) by sieve. Then, they were kept in 1.5 m^3 plastic bags for controlling the moisture and temperature. Some amounts of animal fertilizer, N and P fertilizers were added to them as a fermentation starter and these bags were placed in hot (25 to 30°C) condition. For respiration, some air holes were made on the bags and the moisture was adjusted to 65%. Every week, these materials were mixed together and put into the bags again (During the 3 and 6 months). Then, these palm wastes were used as culture media for tomato cultivation. Seeds of tomato (Izmir cultivar) were planted in cocopeat and transferred to 10 liter pots filled with palm wastes. Irrigation was done by hand and Papadopolus formula (1991) with fertigation method was used for nutrient solution. Average temperature of day and night were 30 and 18°C respectively in greenhouse. During plant growth, temperature and relative humidity of greenhouse and so pest control for all treatments were similar. Leaching of culture media (20%) was performed every fifteen days for prevention of salt accumulation in the culture media. Some physiochemical characteristics of the culture media including bulk density (Baruah and Barthakur 1998), organic carbon (% OC) (Walkley and Black 1934), total porosity (Baruah and Barthakur 1998), water holding capacity (WHC) (Verdonck and Gabriels 1992), cation exchange capacity (CEC) (Rhoades 1982), total nitrogen (N) (Bremner and Mulvaney 1982), electrical conductivity (EC) and pH (Iasiah et al 2004) were measured. For measuring available nitrogen (N), phosphor (P), potassium (K), calcium (Ca), magnesium (Mg) and iron (Fe) of date palm wastes, samples were extracted by $CaCl_2$. 2 H_2O + DTPA then available Ca, Mg and Fe were read by Atomic absorption model of Perkin Elmer Analyst 800 (Bremner and Mulvaney 1982) and available N (Bremner and Mulvaney 1982), P (Olsen and Sommers 1982), K (Kudsen and Peterson 1982) were determined. Concentrations of Ca, Mg and Fe in tomato fruits were read by Atomic absorption model of Perkin Elmer Analyst 800 based on dry matter of tomato fruits. Concentration of N (Bremner and Mulvaney 1982), P (Olsen and Sommers 1982) and K (Kudsen and Peterson 1982) in tomato fruits were measured based on dry matter of tomato fruits. Experimental data normality was verified, and then data were submitted to analysis of variance, using SAS (1997) software package. Means were compared using Duncan multiple test ($p< 0.05$).

RESULTS AND DISCUSSION

Table 1 shows some physicochemical properties of culture media. The highest amount of pH was found in culture media C_3S_1 (6.91). Composting itself leads to major changes in materials and their pH, as decomposition occurs. The initial decrease in pH is due to the formation of organic acids that are formed during degradation. The subsequent increase in pH is due to volatilization of organic acids and accumulation of ammonia (Hellmann et al 1997). Hachicha et al (2008) reported higher surface area in smaller particles caused more decomposition of organic matter and more production of organic acids. Availability of nutrient elements for plants was much more related to the pH of the media, but the composting process was not sensitive to pH, and the effect of pH changes on it was little and limited because microorganisms act at a wide range of pH (Epstein et al 1977, Dinc et al 1984).

Table 1. Some physicochemical properties of culture media

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

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

The maximum amount of bulk density was related to culture media C_1S_1 (0.25 gr/cm^3). It was because of more entered dust in this size during the crashing and sieving. With increasing size fractions, bulk density decreased. It could be due to bigger pores and higher porosity in bigger sizes. In each size, culture media with more composting time (6 months) had more bulk density than culture media with lower composting time (3 months). Because carbon (C) compounds present in organic materials are used by microorganisms as an energy source. As C is lost from the compost pile, the compost becomes more condensed and air spaces within the pile become smaller (Smith Hirrel and Riley 2012) and bulk density is increased. Bulk density is a relevant substrate physical propriety, because this allows easier transportation of crop units in the greenhouse industry (Abad et al, 2004). The highest amount of porosity was observed in culture media C_1S_3 (90%) because of lower bulk density and bigger pores between them. The porosity percentage is an index for root aeration in culture media. When root media aeration is sufficient, supply of water and nutrient elements for plant is easier. The maximum amount of WHC was related to culture media C_2S_1 (94.26%) although it didn't have much difference with culture media C_3S_1 (92.62%). Smaller particles have a larger surface area than those with larger particles; a large surface area allows a media to hold more moisture and to increase WHC which causes poor air-water relationship, leading to low aeration within the medium and effect on oxygen diffusion to the roots. High Ec in palm wastes were due to this matter that dust and solution salt particles had covered date palm leaves and when date palm waste were chopped and sieved, these fractions were released. Composting process generates considerable heat and carbon dioxide (CO_2) also water vapor is released into the air. Lack of CO_2 and water can decrease the weight of the initial materials, thereby reduces the volume and mass of the final product (Pace 1995; Bernal et al 2009). Therefore weight of primary dry matter is decreased and it increases mineral elements concentration and EC. The highest amount of EC was observed in culture media C_1S_1 (6.29 ds/m) and it could be due to increase of dissolution of solutes in smaller particle sizes which had effect on EC. Also with increasing composting time, microbial activity was increased and it released more solutes which had effect on EC. One of the important factors for plant response to compost is EC. Ideal culture media should have Ec equal or less than 0.5 ds/m (Abad et al 2001; Bunt 1988). Abad et al (2005) reported leaching the composts with water decreased substantially the salinity and the concentration of soluble mineral elements. The highest amount of CEC was observed in culture media C_3S_1 (59.11 Cmol/Kg) because smaller particle size had a larger surface area. Also with increasing of composting time CEC was increased. Organic matter degradation causes particles are more chopped in compost pile and so surface area and CEC are increased. With the passage of time, the carboxyl groups from the oxidation of straight chains of aromatic circles or from esters or lactones hydrolysis increased. This increase in carboxylic groups caused an increase in CEC (Lax et al 1987). The maximum amount of C/N ratio was related to culture media C_1S_3 (43.67%). The rate of aerobic decomposition is increased with smaller particle size. Smaller size particles of organic material increase the surface area available for microbial attack. However, very small particles pack tightly together; preventing movement of air into the composting heap and movement of carbon dioxide out of the heap. Large size particles reduce surface area for microbial attack which slows down or may stop composting process altogether (Zia et al 2003). The knowledge of maturity degree of compost is of great importance for compost producers and its consumers. Maturity is a general term describing fitness of compost for a particular end use, mature compost are ready to use (Brewer and Sullivan, 2003). C/N ratio in water extract could serve as a reliable indicator of compost maturity (Chanyasak et al 1983) and in a mature compost C/N ratio is less than or equal to 25 (Schuchardt 2005). Therefore culture media C_3S_3 can be mature compost and culture medias C_3S_1 and C_3S_2 were near the mature compost. It shows in these culture medias biological activity has been decreased and required nutrients are present in adequate amounts for plant growth. Concentrations of available N, P, K, Ca, Mg and Fe in culture media are shown in table 2. Maximum amounts of available N (29.71 mg/kg), Ca (10495.8 mg/kg) and Mg (3650 mg/kg) were related to culture media C_3S_1. Highest concentrations of available Fe (37.22 mg/kg), K (9270.83 mg/kg), and P (457.29 mg/kg) were observed in culture media C_3S_3. Difference in available N, P, K, Ca, Mg and Fe concentrations in different sizes may be result of difference in chemical quality of palm wastes (leaves, crust tree and etc).

Table 2. Concentrations of some available nutrient elements in culture media

Treatment		$N-No_3$ (mg/kg)	P (mg/kg)	K (mg/kg)	Ca (mg/kg)	Mg (mg/kg)	Fe (mg/kg)
composting time	**size**						
C_1S_1 = 0 month	**<0.5 cm**	15.2	103.49	5991.29	5534.44	2271.24	23.15
C_2S_1= 3 months	**<0.5 cm**	25.83	236.67	8289.47	8373.33	3421.05	34.76
C_3S_1= 6 months	**<0.5 cm**	29.71	304.39	8500	10495.8	3650	36.68
C_1S_2= 0 month	**0.5-1 cm**	13.74	99.37	5895.39	8134.54	3114.1	20.82
C_2S_2= 3 months	**0.5-1 cm**	26.46	284.5	7258.06	9001.23	3395.05	29.1
C_3S_2= 6 months	**0.5-1 cm**	27.78	378.51	7329.32	9210.53	3386.38	36.16
C_1S_3= 0 month	**1-2 cm**	12.92	95.31	5885.42	8782.1	3298.51	14.32
C_2S_3= 3 months	**1-2 cm**	20.99	334.38	7772.34	8997.96	3359.98	19.97
C_3S_3= 6 months	**1-2 cm**	24.22	457.29	9270.83	8996.86	3348.29	37.22

Separated effects of composting time, particle size and irrigation of palm wastes on N, P, K, Ca, Mg and Fe in tomato fruit are shown in table 3. Different particle sizes of palm wastes had significant effect on N, P, K, Ca, Mg and Fe in tomato fruit ($p< 0.05$). The highest concentrations of N, P, K, Ca, Mg and Fe were related to particle size of 0.5-1 cm. A good growing media would provide sufficient anchorage to the plant, serves as reservoir for nutrients and water, allow oxygen diffusion to the roots and permit gaseous exchange between the roots and atmosphere outside the root substrate (Bunt 1988). Loehr (2010) studied the effect of particle size of compost on mushroom and reported particle sizes of 0.65 cm are better than larger particles for culture media. Benito et al (2005) reported the best substrate was substrate with medium to coarse texture, equivalent to a particle size distribution between 0.25 and 2.5 mm, that allows retention of enough readily available water together with adequate air content.

On the other hand, Handreck (1983) studied the particle size and physical properties of container media and concluded that the fraction smaller than 0.5 mm, and in particular between 0.1 and 0.25 mm, had the highest influence on porosity and water retention. Pustjarvi and Robertson (1975) indicated that if the rate of peat bed particles be less than 0.01mm, the particles become so small that the pot aeration capacity is reduced. Therefore the diameter of bed ingredient particle must be in 0.01-0.8 mm, until it can have the highest aeration space, while also water holding capacity is maximum in the moss peat bed. Different composting times of palm wastes had significant effect on N, P, K, Ca, Mg and Fe in tomato fruit ($p< 0.05$).

Table 3. Separated effects of composting time, particle size and irrigation of palm wastes on some nutrient elements in tomato fruit

Treatment	N (%)	P (%)	K (%)	Ca (%)	Mg (%)	Fe (mg/kg)
Composting time						
0 month	1.36[c]	0.41[c]	2.1[c]	0.31[c]	0.31[c]	19.09[b]
3 months	1.57[b]	0.43[b]	2.12[b]	0.33[b]	0.36[b]	21.3[a]
6 months	1.67[a]	0.44[a]	2.29[a]	0.38[a]	0.41[a]	21.48[a]
Particle size						
< 0.5 cm	1.52[b]	0.41[c]	2.12[b]	0.27[c]	0.25[c]	19.38[b]
0.5-1 cm	1.57[a]	0.45[a]	2.24[a]	0.46[a]	0.48[a]	22.66[a]
1-2 cm	1.51[c]	0.42[b]	2.14[b]	0.29[b]	0.36[b]	19.81[b]
Irrigation						
1.8 Liters	1.51[b]	0.42[c]	2.14[b]	0.31[c]	0.34[c]	20.02[c]
2.4 Liters	1.54[a]	0.42[b]	2.15[b]	0.35[b]	0.36[b]	20.61[b]
3 Liters	1.55[a]	0.44[a]	2.21[a]	0.37[a]	0.38[a]	21.21[a]

The highest amounts of N, P, K, Ca, Mg and Fe were related to composting time of 6 months. It could be due to maturity of compost. Maturity is associated with plant-growth potential and mature compost gives plants an advantage in increased nutrients and water availability, and reduces disease pressures (Christian et al 2009, Iannotti et al 1993). Forster et al (1993) reported the best definition for maturity of compost is applied concept of it with attention to plant response. In this research the best response to culture media was in culture media with 6 months composting time with regards to quality of tomato. Carmona et al (2012) studied composting of wine industry wastes and their use as a substrate for growing soilless ornamental plants (geranium, petunia, carnation and gerbera) and reported that compost had no limiting characteristics for its use as a medium for the cultivation of ornamental plants in container, and could replace conventional substrates, such as peat and coconut fiber.

Table 4. Some nutrient elements of tomato cultivated in culture media

Treatment			N	P	K	Ca	Mg	Fe
Composting time	**Size**	**Irrigation**	**(%)**	**(%)**	**(%)**	**(%)**	**(%)**	**(mg/kg)**
$C_1S_1I_1$ = 0 month	**<0.5 cm**	**0.6 T**	1.32^{kl}	0.41^{hijk}	2.11^{gfh}	0.21^{m}	0.21^{n}	16.93^{no}
$C_2S_1I_1$ = 3 months	**<0.5 cm**	**0.6 T**	1.56^{fg}	0.41^{hijk}	2.073^{gh}	0.22^{m}	0.23^{m}	21.13^{i}
$C_3S_1I_1$ = 6 months	**<0.5 cm**	**0.6 T**	1.64^{dc}	0.41^{hijk}	2.11^{gfh}	0.33^{j}	0.22^{mn}	18.64^{k}
$C_1S_2I_1$ = 0 month	**0.5-1cm**	**0.6 T**	1.35^{jk}	0.41^{hijk}	2.04^{h}	0.42^{g}	0.42^{e}	22.38^{d}
$C_2S_2I_1$ = 3 months	**0.5-1cm**	**0.6 T**	1.59^{ef}	0.44^{de}	2.09^{gh}	0.39^{h}	0.42^{e}	21.12^{i}
$C_3S_2I_1$ = 6 months	**0.5-1cm**	**0.6 T**	1.66^{bc}	0.42^{jhig}	2.4^{b}	0.46^{ed}	0.53^{c}	22.79^{c}
$C_1S_3I_1$ = 0 month	**1-2 cm**	**0.6 T**	1.36^{j}	0.41^{hijk}	2.07^{h}	0.32^{jk}	0.31^{j}	17.09^{n}
$C_2S_3I_1$ = 3 months	**1-2 cm**	**0.6 T**	1.47^{h}	0.41^{hijk}	2.11^{gfh}	0.21^{m}	0.35^{i}	20.08^{j}
$C_3S_3I_1$ = 6 months	**1-2 cm**	**0.6 T**	1.64^{dc}	0.42^{ghij}	2.27^{d}	0.21^{m}	0.38^{gh}	20.08^{j}
$C_1S_1I_2$ = 0 month	**<0.5 cm**	**0.8 T**	1.31^{kl}	0.39^{k}	2.065^{h}	0.21^{m}	0.21^{n}	16.88^{o}
$C_2S_1I_2$ = 3 months	**<0.5 cm**	**0.8 T**	1.59^{ef}	0.41^{hijk}	2.18^{fe}	0.26^{l}	0.27^{l}	21.15^{i}
$C_3S_1I_2$ = 6 months	**<0.5 cm**	**0.8 T**	1.69^{ab}	0.43^{efgh}	2.11^{gfh}	0.36^{i}	0.28^{kl}	20.08^{j}
$C_1S_2I_2$ = 0 month	**0.5-1cm**	**0.8 T**	1.43^{i}	0.43^{efgh}	2.11^{gfh}	0.43^{f}	0.42^{e}	22.39^{d}
$C_2S_2I_2$ = 3 months	**0.5-1cm**	**0.8 T**	1.64^{dc}	0.44^{de}	2.16^{gfe}	0.48^{c}	0.45^{d}	21.33^{h}
$C_3S_2I_2$ = 6 months	**0.5-1cm**	**0.8 T**	1.71^{a}	0.46^{c}	2.36^{bc}	0.49^{b}	0.57^{b}	23.71^{b}
$C_1S_3I_2$ = 0 month	**1-2 cm**	**0.8 T**	1.36^{j}	0.4^{jk}	2.1^{gfh}	0.27^{l}	0.31^{j}	17.09^{n}
$C_2S_3I_2$ = 3 months	**1-2 cm**	**0.8 T**	1.53^{g}	0.42^{ghij}	2.05^{h}	0.31^{k}	0.37^{h}	21.09^{i}
$C_3S_3I_2$ = 6 months	**1-2 cm**	**0.8 T**	1.63^{cd}	0.44^{def}	2.23^{de}	0.32^{jk}	0.39^{fg}	21.79^{f}
$C_1S_1I_3$ = 0 month	**<0.5 cm**	**T**	1.3^{l}	0.41^{hijk}	2.08^{gh}	0.21^{m}	0.22^{mn}	17.42^{m}
$C_2S_1I_3$ = 3 months	**<0.5 cm**	**T**	1.61^{de}	0.42^{ghij}	2.12^{gfh}	0.31^{k}	0.29^{k}	21.59^{g}
$C_3S_1I_3$ = 6 months	**<0.5 cm**	**T**	1.68^{ab}	0.43^{efg}	2.26^{d}	0.33^{j}	0.31^{j}	20.08^{j}
$C_1S_2I_3$ = 0 month	**0.5-1cm**	**T**	1.44^{hi}	0.45^{d}	2.21^{de}	0.45^{e}	0.4^{f}	23.59^{b}
$C_2S_2I_3$ = 3 months	**0.5-1cm**	**T**	1.61^{de}	0.49^{b}	2.22^{de}	0.47^{cd}	0.46^{d}	22.51^{d}
$C_3S_2I_3$ = 6 months	**0.5-1cm**	**T**	1.72^{a}	0.51^{a}	2.56^{a}	0.56^{a}	0.63^{a}	24.12^{a}
$C_1S_3I_3$ = 0 month	**1-2 cm**	**T**	1.35^{jk}	0.41^{hijk}	2.08^{gh}	0.31^{k}	0.31^{j}	17.42^{m}
$C_2S_3I_3$ = 3 months	**1-2 cm**	**T**	1.59^{ef}	0.44^{de}	2.1^{gfh}	0.35^{i}	0.37^{h}	21.59^{g}
$C_3S_3I_3$ = 6 months	**1-2 cm**	**T**	1.66^{bc}	0.45^{d}	2.29^{dc}	0.36^{i}	0.42^{e}	22.08^{e}

Different irrigations had significant effect on N, P, K, Ca, Mg and Fe in tomato fruit ($p< 0.05$). The highest concentration of N, P, K, Ca, Mg and Fe were recorded on irrigation of three liters. Increasing the irrigation amounts resulted in increased N, P, K, Ca, Mg and Fe in tomato fruit. It seems more content of irrigation with nutrient solution provides higher N, P, K, Ca, Mg and Fe for plant uptake. The frequency of irrigation and the quantity of nutrient solution provided to the plants vary among growing medias and this will affect on yield and fruit quality (Tüzel *et al* 1993). Frequent irrigation and continued fertilization should satisfy nutritional plant demands under most practical situations (Raviv *et al* 2002). Comparison means of treatments in N, P, K, Ca, Mg and Fe of tomato fruit are shown in table 4. There were significant difference between treatments in N, P, K, Ca, Mg and Fe of tomato fruit ($p< 0.05$). Maximum concentrations of N, P, K, Ca, Mg and Fe in tomato fruit were observed in treatment $C_3S_2I_3$. From the above discussion it could be concluded that properties of culture media and amounts of irrigation with nutrient solution affected on concentration these nutrients absorption by plant. Borji et al (2012) showed substrates (Palm peat 1, Palm peat 2, Perlite, Palm peat 1+Perlite and Palm peat 2+Perlite) had significant difference at 5% level in concentration of Fe in fruits and maximum concentration of Fe were related to palm peat 1+perlite and perlite respectively also reported there were no significant difference in N, P and K of tomato fruit. Premuzic et al (1998) reported tomato fruit grown on organic substrates contained significantly more Ca and less Fe than fruit grown on hydroponic media. Mohammadi et al (2011) reported N, P and K of tomato fruit in date palm and perlite media had no significant difference at 5 % level. 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 and there was significant difference between treatments in fruit Fe. The results of Saberi et al (2006) showed that substrates (mica, rice hull, coco peat, perlite and zeolite) had significant difference in Ca of tomato and no significant difference on concentration of phosphorus in fruit. Borji et al (2010) showed there was no significant difference in concentrations of Ca and Mg in tomato fruits of different substrates.

CONCLUSIONS

The overall results of this study indicated culture media quality is one of the most important influences on fruit quality. A good culture media has both the chemical and physical properties that promote healthy of fruit. Nutrient elements content especially potassium content is important for the nutritional value of tomato. Iron and calcium plays an important role in tomato nutrition and fruit quality, they are essential for bone development and efficient oxygen carrier in blood system respectively.

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REFERENCES

Abad, M., Fornes, F. & Noguera, V. (2005): Leaching of Composts from Agricultural Wastes to Prepare Nursery. *Potting Media.*, 117-124.

Abad, M., Noguera, P., Bures, S. 2001. National inventory of organic wastes for use as growing media for ornamental potted plant production: case study in Spain. Biores. Technol., 77: 197-200.

Abad, M.; Noguera, P. & Carrion, C. (2004): Los sustratos en los cultivos sin suelo. In: M., Urrestarazu (Eds.), *Manual del cultivo sin suelo*. Servicio de Publicaciones Universidad de Almerda. *Mundi-Prensa, Madrid*., pp. 113-158.

Abad, M., Noguera, P., Noguera, V., Roig, A., Cegarra, J. & Paredes, C. (1997): Reciclado de residues organicos y su aprovechamiento como sustratos de cultivo. *Actas de Horticultura.,* 19: 92-109

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. *Journal of Science Technology*., 1: 19-25.

Barreveld, W.H. (1993): Date palm products. FAO, *Agriculture Services Bulletin*., 101.

Baruah, T.C. & Barthakur, H.B. (1998): A Textbook of Soil Analysis. PMT Ltd, New Dehli, India: Vikas Publishing House., pp: 282.

Benito, M., Masaguer, A., Moliner, A. & Antonio, R.D. (2006): Chemical and physical properties of pruning waste compost and their seasonal variability. *Bioresource Technology*., 97: 2071-2076.

Bernal, M.P., Alburquerque, J.A. & Mora, R. (2009): Composting of animal manures and chemical criteria for compost maturity assessment. A review. Bioresources. *Technolohy*., 100: 5444-5453

Bunt, A.C. (1988): Media and Mixes for Container-Grown Plants. *A manual on the preparation and use of growing media for pot plant.,* 2: 309

Borji, H., Mohammadi-Ghehsareh, A. & Jafarpour, M. (2012): Effect of date-palm and perlite substrates on nutrients content and quality of tomato grown in soilless culture. *Resources on Crops*., 13 (1): 258-261.

Borji, H., Mohammadi-Ghehsareh, A. & Jafarpour, M. (2010): Effects of the Substrate on Tomato in Soilless Culture. *Research Journal of Agricultural Biologic Science.,* 6(6): 923-927.

Bremner, J.M. & Mulvaney, C.S. (1982): Nitrogen-total. In: Methods of soil analysis. (Page, A.L., Miller, R.H. & Keeney, D.R. Eds) pp. 595–522. (Part 2- Chemical and microbiological properties. 2nd ed., Agronomy 9).

Brewer, L. & Sullivan, D. (2003): Maturity and Stability Evaluation of Composted Yard Trimmings. *Compost Sci Util*., 11: 96-112.

Carmona, E., Moreno, M.T., Avilés, M. & Ordovas, J. (2012): Composting of wine industry wastes and their use as a substrate for growing soilless ornamental plants. *Spain Journal of Agriculture Research.,* 12: 21-28.

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

Chanyasak, V., Katayama, A., Hirai, M., Mori, S. & Kubota, H. 1983. Effects of compost maturity on growth of Komatsuna (Brassica Rapa var. Pervidis) in Neubauer's pot. II. Growth inhibitory factors and assessment of degree of maturity by org-C/org-N ratio of water extracts. *Soil Science and Plant Nutrition*., 29 (3): 251-259.

Christian, A.H., Evanylo, G.K. & Green, R. (2009): Compost: What Is It and What's It To You. *Virginia State University Publication*., 452-231.

Dinc, U., Cevic, B. & Kaska, N. (1984): A preliminary study on the effect of volcanic ash organic soil for early production, yield and quality of tomatoes. *Acta Hortic*., 150: 277-282.

Eklind, Y. (1998): Carbon and Nitrogen Turnover During Composting And Quality of the Compost Product. Doctoral Thesis, Swedish University of Agricultural Sciences, Uppsala, 28 pp.

Epstein, E., Wilson, G.B. & Parr, J.F. (1977): The Beltsville aerated pile method for composting sewage sludge. In: New Processes of Waste Water Treatment and Recovery. Soc. Chem. Ind. London, UK. pp. 201-213.

Forster, J.C., Zech, W. & Wurdinger, E. (1993): Comparison of chemical and microbiological methods for the characterization of the maturity of composts from contrasting sources. *Biol Fertil Soils*., 16(2): 93-99.

Grunert, O., Perneel, M. & Vandaele, S. (2008): Peat-based organic growbags as a solution to the mineral wool waste problem. *Mires and Peat*., 3: 1-5.

Hachicha, S., Fatma, S., Khaied, M., Hachicha, R. & Ammar, E. (2008): Quality assessment of composts prepared with olive mill wastewater and agricultural wastes. *Waste Management*., 28: 2593-2603.

Handreck, K.A. (1983): Particle size and the physical properties of growing media for containers. Commun. *Soil Sci Plant Anal*., 14(3): 209-222.

Hellmann, B., Zelles, L., Palojarvi, A. & Bai, Q. (1997): Emissions of climate-relevant trace gases and succession of microbial communities during open-windrow composting. *Applied and Environmental Microbiology*., 63: 1011-1018.

Hoitink, H.A.J., Stone, A.G. & Han, D.Y. (1997): Suppression of plant diseases by composts. *Hort Science*., 32(2): 184–187.

Iannotti, D.A., Pang, T., Toth, B.L., Elwell, D.L., Keener, H.M. & Hoitink, H.A.J. (1993): A quantitative respirometric method for monitoring compost stability. *Compost Sci Utilization*., 1: 52-6.5.

Iasiah, A., Mohd Razi, I., Mohd Khanif, Y., Marziah, M. & Shaharuddin, M. (2004): Physical and Chemical Properties of Coconut Coir Dust and Oil Palm Empty Fruit Bunch and the Growth of Hybrid Heat Tolerant Cauliflower Plant. *Pertanika J Trap Agric Sci*., 27(2): 121-133.

Lax, A., Costa, F., Roig, A., Hernandez, M.T. & Cegarra, J. (1987): Indexes of humification grade in manures. *Sci Total Environ*., 62: 457–458.

Linderman, R.G & Davis, E.A. (2003): Arbusular mycorrhiza and growth responses of several ornamental plants grown in soilless peat-based medium amended with coconut dust. *HorTechnology*., 13: 482-487.

Loehr, S. (2010): Minimally composted substrate for production of agaricus bisporus. 52nd Mushroom Short Course.

Mohammadi-Ghehsareh, A., Samadi, N. & Borji, H. (2011): Comparison of date palm wastes and perlite as growth substrates on some tomato growing indexes. *Afr J Biotechno.,l* 10(24): 4871-4878.

Pace, M.G. (1995): Graduate Research Assistant; Bruce E. Miller, Assistant Professor, Kathryn L. Farrell-Poe, Extension Environmental Engineer; Ag. Systems Tech. & Ed. Dept

Papadopolus, A.D. (1991): Growing greenhouse tomatoes in soil and soilless. pp. 79. (Communication Branch, Agric. Canada. Ottawa).

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

Puustjarvi, V. & Robertson, R.A. (1975): Physical and chemical properties, P.23-38. peat in horticulture, Robertson D.W. & Lamb J.G.D. ed. Chap. 2. academic press, London.

Raviv, M., Wallach R., Silber A., & Bar-Tal A (2002). Substrates and their analysis. In Hydroponic production of vegetables and ornamentals (D. Savvas, and H. Passam, eds). Athens: Embryo Publications, pp.25–101.

Rhoades, J.D. (1982): Cation exchange capacity. In: Methods of soil analysis. (Page A.L. ed.) pp. 149-157. (Agron. No. 9, Part 2: Chemical and mineralogical properties, Am. Soc. Agron., Madison, WI, USA).

Saberi, Z. (2009): Use of zeolite, vermiculate and some inert materials as media for hydroponic tomato production. Master’s thesis in Soil Science, Isfahan University of

SAS Institute: SAS User's Guide Statistics / SAS Institute, Inc., Cary, NC. 1997.

Schuchardt, F. (2005): Composting of Organic Waste. Environmental Biotechnology, Concepts and Applications, Verlag GmbH & Co. KGaA, Weinheim.

Smith Hirrel, S. & Riley, T. (2012): Understanding the composting process. University of Arkansas, United States Department of Agriculture, and County Governments Cooperating, http://www.uaex.edu

Tüzel, Y., Ul, M.A., Tüzel, I.H., Cockshull K.E. & Gul, A. (1993): Effects of different irrigation intervals and rates on spring season glasshouse tomato production: II. Fruit quality. *Acta Horticulturae*., 366: 389-396.

Verdonck, O. & Gabriels, R. (1992): Reference method for the determination of physical properties of plant substrates.II. Reference method for the determination of chemical properties of plant substrates. *Acta Horticulturae*., 302: 169-179.

Veeken, A., de Wilde, V., Woelders, H. & Hamelers, B. (2004): Advanced bioconversion of biowaste for production of a peat substitute and renewable energy. *Bioresour Technol*., 92: 121-131.

Walkley, A. & Black, I.A. (1934): An examination of the Degtjareff method for determining soil organic matter and a proposed modification of the chromic acid titration method. *Soil Science*., 37: 29-38.

Zia, M.S., Khalil, S., Aslam, M. & Hussain F. (2003): Preparation of compost and its use for crop-production. *Sci Tech Develop*., 22: 32-44.

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UTICAJ OTPADA PALME URME KAO PODLOGE NA ODREĐENE ELEMENTE NUTRIJENATA PLODOVA PARADAJZA

SAŽETAK

U mnogim zemljama koriste se tehnike proizvodnje bez zemljišta, posebno u zatvorenom prostoru. Eksperiment je izvršen na bloku sa šemom nasumičnog redosljeda sa 27 tretmana i 4 replikacije. Tretman je izvršen sa tri veličine ljuspi (S1= <0.5, S2=0.5-1 i S3=1-2 cm), tri perioda kompostiranja (C1=0, C2=3 i C3=6 mjeseci) i tri nivoa navodnjavanja (I1 =1.8, I2= 2.4 i I3=3 litara). Tokom rasta paradajza, korišćena je Papadopulos formula sa metodom fertirigacije kao nutrijent. Najviši nivo poroznosti i odnos ugljenik/azot imala je podloga C1S3. Različiti nivoi navodnjavanja, veličina ljuspi i vremena kompostiranja otpada od palme imala su značajan uticaj na sadržaj N, P, K, Ca, Mg i Fe u plodovima paradajza ($p< 0.05$). Maksimalne koncentracije N, P, K, Ca, Mg i Fe u plodovima paradajza dobijene su tretmanom C3S2I3 ($p< 0.05$). Ukupni rezultati ovog istraživanja ukazuju da je kvalitet podloge ima među najvećim uticajima na kvalitet ploda. Dobra podloga za rast ima i hemijska i fizička svojstva koja podstiču zdrav plod. Sadržaj nutrijenata a posebno sadržaj kalijuma je važno nutritivno svojstvo paradajza. Gvožđe i kalcijim imaju značajnu ulogu u ishrani paradajza i kvalitetu plodova a od presudnog su značaja za razvoj kostiju i efikasan transport kiseonika u krvotoku.

Ključne riječi: vrijeme kompostiranja, otpad palme urme, veličina ljuspi, proizvodnja bez zemljišta, paradajz