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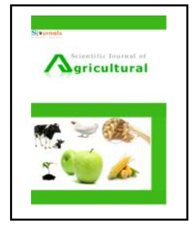

Original article

Effect of some treatments of date-palm waste as a culture media on some tomato fruit properties

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Use of suitable growing media or substrates is essential for production of horticultural crops. The experiment was conducted as factorial in a completely randomized block design with 9 treatments and 4 replications. Treatments included three particle sizes (S_1= <0.5, S_2=0.5-1 and S_3=1-2 cm) and three composting times (C_1=0, C_2=3 and C_3=6 months) of date palm waste. During tomato growth Papadopolus formula with fertigation method was used for nutrient solution. Different sizes and composting times of date palm waste had significant effect on N, P, K, number and yield of fruit (p< 0.05). Comparison of different sizes showed highest amounts of N, P, K, number and yield were related to particle size of 0.5-1 cm. Comparison of different composting times illustrated maximum amounts of N, P, K, number and yield were observed in composting time of 6 months. The overall result of this study indicated culture media quality is one of the most important influences on fruit yield and quality. A good culture media has both the chemical and physical properties that promote healthy and yield of fruit.

1. Introduction

Use of suitable growing media or substrates is essential for production of horticultural crops. Nowadays, numerous studies have demonstrated that the organic residues, including livestock solid waste, sewage sludge and even green plant waste, after proper composting, can be used with very desirable results as growth media (Piamonti et al., 1997, Garcia-Gomez et al., 2002). Among organic residues used successfully as soilless planting media is the compost from green residues (Spiers and Fietje, 2000). Date-palm (Phoenix dactylifera) extensively exist in the world and produce a lot of waste per annum (Barreveld, 1993). Presently, there are no suitable and optimal management on palm waste. Mohammadi-Ghehsareh et al. (2011) showed that date-palm waste could be a media for soilless culture with suitable physical and chemical properties, available and low cost. The objective of this study is to assess the effect of some treatments of Date-Palm waste as a culture media on some tomato fruit properties.

2. Materials and methods

This study was performed in the greenhouse research site of Isfahan Azad University (Khorasgan). The experiment was conducted as factorial in a completely randomized block design with 9 treatments and 4 replications. 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 after the starting date). Then, these date palm wastes were used as culture media for tomato cultivation. Treatments were three composting times (C) and three sizes (S) included: C_1S_1= (size 0-0.5 cm + 0 month composted), C_2S_1= (size 0-0.5 cm + 3 months composted), C_3S_1= (size 0-0.5 cm + 6 months composted), C_1S_2= (size 0.5-1 cm + 0 month composted), C_2S_2= (size 0.5-1 cm + 3 months composted), C_3S_2= (size 0.5-1 cm + 6 months composted), C_1S_3= (size 1-2 cm + 0 month composted), C_2S_3= (size 1-2 cm + 3 months composted), C_3S_3= (size 1-2 cm + 6 months composted). Seeds of tomato (Izmir cultivar) were planted in cocopeat. After transplanting growth, they were transferred to 10 liter pots filled with above treatments. 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, irrigation rate, temperature, humidity and pest control for all treatments were similar. Leaching of culture medias (20%) were performed every fifteen days. Some physiochemical characteristics of the culture media including bulk density (Baruah and Barthakur, 1998), organic carbon (% OC) (Walkley and Black, 1934), porosity (Baruah and Barthakur, 1998), water holding capacity (WHC) (Verdonck and Gabriels, 1992), cation exchange capacity (CEC) (Rhoades, 1982), electrical conductivity (EC) and pH (Iasiah et al., 2004) were measured. For measuring available nitrogen (N), phosphor (P) and potassium (K) of date palm waste, samples were extracted by $CaCl_2$. 2 H_2O + DTPA then available N (Bremner and Mulvaney, 1982), P (Olsen and Sommers, 1982) and K (Kudsen and Peterson, 1982) were determined. Yield (by digital scale) and number of tomato fruit were measured. Concentrations of N (Bremner and Mulvaney, 1982), P (Olsen and Sommers, 1982) and K (Kudsen and Peterson 1982) of tomato fruit were determined 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 ($p < 0.05$).

3. Results

Some physicochemical properties of culture medias are shown in table 1. Highest amount of EC and BD were observed in culture media C_1S_1. Maximum amount of pH and CEC were found in culture media C_3S_1. The maximum amount of C/N ratio was related to culture media C_1S_3. The most amount of porosity was observed in culture media C_1S_3.
Highest amount of WHC was related to culture media C_2S_1 although it didn't have much difference with culture media C_3S_1. Table 2 shows concentration of available N, P and K in culture medias. Maximum amounts of available K and P were related to culture media C_3S_3 and highest amount of available N was observed in culture media C_3S_1.

Table 3 illustrates separated effects of composting time and particle size of culture medias on N, P, K, number and yield of tomato fruit. Different sizes of culture media had significant effect on N, P, K, number and yield of tomato fruit ($p< 0.05$). The highest amounts of N, P, K, number and yield were related to particle size of 0.5-1 cm. Different composting times of culture media had significant effect on N, P, K, number and yield of tomato fruit ($p< 0.05$). The highest amounts of N, P, K, number and yield were related to composting time of 6 months.

Table 1
Some physicochemical properties of culture medias.

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

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

Table 2
Concentrations of available N, P and K in culture medias.

Treatment		N-No_3	P	K
composting time	**Size**	**(mg/kg)**	**(mg/kg)**	**(mg/kg)**
C_1S_1 = 0 month	<0.5 cm	15.20	103.49	5991.29
C_2S_1= 3 months	<0.5 cm	25.83	236.67	8289.47
C_3S_1= 6 months	<0.5 cm	29.71	304.39	8500
C_1S_2= 0 month	0.5-1 cm	13.74	99.37	5895.39
C_2S_2= 3 months	0.5-1 cm	26.46	284.5	7258.06
C_3S_2= 6 months	0.5-1 cm	27.78	378.51	7329.32
C_1S_3= 0 month	1-2 cm	12.92	95.31	5885.42
C_2S_3= 3 months	1-2 cm	20.99	334.38	7772.34
C_3S_3= 6 months	1-2 cm	24.22	457.29	9270.83

4. Discussion

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 wastes were chopped and sieved, these fractions were released. Highest amount of EC in culture media C_1S_1 could be due to increase of dissolution of solutes in smaller particle size which had effect on EC. Carbon (C) compounds present in organic materials are used by microorganisms as an energy source, transformed into carbon dioxide (Co_2) and released into the environment. Lack of Co_2 and water can decrease the weight of the initial materials, thereby reduces the volume and mass of the final product (Bernal et al., 2009). Therefore weight of primary dry matter is decreased and it increases mineral elements concentration and 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 culture media is EC. Abad et al. (2005) reported leaching the composts with water decreased substantially the salinity and the concentration of soluble mineral elements. That is why leaching the culture medias were performed in this research. Maximum pH in culture media C_3S_1 could be due to this matter that 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 plant is much more related to the pH of the media, but the composting process is not sensitive to pH because microorganisms act at a wide range of pH (Epstein et al., 1977, Dinc et al., 1984).

Table 3
Separated effects of composting time and particle size of culture medias on N, P, K, number and yield of tomato fruit.

Treatment	N (%)	P (%)	K (%)	Number	Yield (Kg)
Size					
S_1 = < 0.5 cm	1.52^{b}	0.41^{b}	2.12^{b}	69.97^{ab}	8.67^{ab}
S_2 = 0.5-1 cm	1.57^{a}	0.45^{a}	2.24^{a}	73.18^{a}	9.16^{a}
S_3 = 1-2 cm	1.51^{b}	0.43^{b}	2.14^{b}	68.19^{b}	8.17^{b}
Composting time					
C_1 = 0 month	1.36^{c}	0.41^{c}	2.1^{c}	66.86^{b}	7.96^{b}
C_2 = 3 months	1.57^{b}	0.43^{b}	2.12^{b}	69.14^{b}	8.97^{a}
C_3 = 6 months	1.67^{a}	0.44^{a}	2.29^{a}	75.33^{a}	9.07^{a}

[a,b,c] Columns that do not share the same letters differ significantly ($P< 0.05$).

The highest amount of CEC in culture media C_3S_1 was because of smaller sizes had a larger surface area. Also with increasing of composting time CEC was increased. Also organic matter degradation caused particles were more chopped in compost pile and so surface area and CEC increased. Fontanive et al. (2004) reported CEC increased through the composting process was due to changing of organic matters and transforming into humic. C/N ratio in water extract could serve as a reliable indicator of compost maturity (Chanyasak et al., 1983). Microorganisms need carbon and nitrogen for their metabolism. Smaller sizes 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 particles reduce surface area for microbial attack which slows down or may stop composting process altogether (Zia et al., 2003; Eklind, 1998).The maximum amount of bulk density in culture media C_1S_1 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 of losing carbon from the compost pile and getting smaller the spaces within the compost pile during composting process. Kaila (1956) reported bulk density could be used as a basis for estimating the degree of decomposition of peats. Highest of porosity in culture media C_1S_3 could be due to lower bulk density and bigger pores between them. The porosity percentage is an index for root aeration in culture media. Maximum amount of WHC in culture media C_2S_1 and C_3S_1 in compare to other culture media could be due to smaller particles have a larger surface area than those with larger particles and a large surface area allows a media to hold more moisture and to increase WHC. Difference in available elements concentration in different sizes may be result of difference in chemical quality of palm wastes (leaves, crust tree and etc).

Highest amounts of N, P, K, number and yield in particle size of 0.5-1 cm showed this size of palm wastes was better for using it as culture media in compare with other sizes according to its yield and fruit quality. 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. The highest amounts of N, P, K, number and yield in composting time of 6 months could be due to maturity of compost. 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 composting time of 6 months with regards to its yield and tomato quality. It showed in culture media with composting time of 6 months, biological activity has been decreased and required nutrients are present in adequate amounts for plant growth. 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). Carmona et al. (2012) studied Composting of wine industry wastes and their use as a substrate for growing soilless ornamental plants and reported that compost had no limiting characteristics for its use as a culture media. Some investigation showed composting of fruit and vegetable wastes improved growth and yield of wheat and maize (Ahmad et al., 2007, Zahir et al., 2007). Mohammadi et al. (2011) reported tomato fruit yield, number, N, P and K in date palm and perlite media had no significant difference at 5 % level. Hematian et al. (2012) investigated the effect of addition of some organic waste to soil on yield and some growth indices of greenhouse cucumber and reported higher yield were obtained from pure palm peat media. 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.

5. Conclusion

The overall results of this research indicated culture media quality is one of the most important influences on yield and quality of fruit. A good culture media has both the chemical and physical properties that promote healthy and yield of fruit. Nutrient elements content especially potassium is important for the nutritional value of tomato; they have beneficial effects on human health.

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