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Full Length Research Paper

Effect of addition of organic and inorganic combinations to soil on growing property of greenhouse cucumber

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This research was carried out using a completely randomized design with seven treatments and seven replications. The treatments were perlite, date palm waste, soil, perlite + soil (Pe + s, w/w= 5/95), perlite + soil (w/w = 10/90), date palm waste + soil (w/w = 5/95) and date palm waste + soil (Pa+s, w/w= 10/90). The physiochemical characteristics of substrates were measured before plant cultivation. Some growth indices were measured at the end of the growth period. The results show that the amount of cucumber yield, number of fruit, biomass weight, plant height, stem diameter of plant and leaf area index in date palm wastes were highest. The amount of fruit stiffness index in date palm wastes and perlite media were highest but the amount of fruit total soluble solids (TSS) in date palm wastes media was lowest and had significant difference with other substrates. The concentration of P, K and Ca in all substrates had no significant difference. The concentration of Mg in Pa+s (w/w=10/90) and Pe + s (w/w= 5/95) substrates had the lowest content and had significant differences as compared with other treatments. The concentration of Fe, Mn and Zn in plant leaf in perlite media was higher than for the other treatments.

Key words: Date palm waste, perlite, substrate, greenhouse, cucumber.

INTRODUCTION

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). 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 (Olympious, 1992). Crop residues of common cultivated crops are an important resource not only as a source of significant quantities of nutrients for crop production but also affecting soil physical, chemical, and biological functions and properties and water and soil quality. When crop residues are returned to the soils, their decomposition can have both positive and negative effects on crop production and the environment (Kumar and Goh, 1999).

The palm oil industries are one of the significant sources of agricultural wastes which can be used as organic fertilizers (Aisueni and Omoti, 1999). Applications of agricultural wastes into agricultural soil after bio-processing not only supplies nutrients to plants, but also improves physical, chemical and biological properties of plants as well as fertility of the soil (Bansal and Kapoor, 2000). Solid wastes can be either directly added to the

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soil (Lerch et al., 1992; Singh and Agrawal, 2007, 2009, 2010a, b; Silva et al., 2010) or sometimes require some pretreatment prior to its soil amendment during the presence of toxic pollutants or pathogenic micro-organisms in it (Hassen et al., 2001). Results on the effect of combination of some substrates such as perlite and compost with soil for tomato plant investigated by Javanpour et al. (2005) showed that quality and quantity of tomato in the different substrates soil treatment had no significant difference. Effect of the substrate on yield and fruit quality of tomato in soilless culture studied by Tzortzakis and 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 no effect on electrochemical conductivity (EC), pH and dry matter content. The results suggest that addition of maize to perlite and pumice could improve properties of inorganic substrates for tomato soilless culture, leading to higher yields and better quality fruit (Tzortzakis and Economakis 2008). Samiei et al. (2005) investigated effect of peat moss and date palm wastes as substrates on the growing of Aglaonema and his results show that peat moss and date palm peat were similar in some characteristics such as cation exchange capacity (CEC), pH, EC and organic carbon but water holding capacity in peat moss was higher than date palm peat. The effect of some culture substrates on date palm peat, coco peat and perlite on some tomatoes growing indices were studied by Mohammadi Ghehsareh et al. (2011). The treatments were coco peat + perlite (v/v=50%), date palm peat + perlite (v/v=50%), perlite (100%) and date palm peat (100%). The results show that the media had not any significant effect on yield and concentration of nutrient elements in fruit such as N, P and K in all treatments. Higher amount of total soluble solids (TSS) related to coco peat + perlite treatment has no significant difference with date palm peat + perlite, perlite and date palm peat treatments. Comparison of tomato growing indices in different substrates including perlite, date palm 1 (without composting time) and date palm 2 (with three months composting time) were studied by Mohammadi Ghehsareh et al. (2011) and the results show that fruit yield, plant height and fruit number of tomato in different substrates had no significant differences at 5% level but stem diameter and biomass in date palm 1 was higher than for other media and had significant differences at 5% level.

Date palm extensively exists in the world and produces an amount of residues and wastes per annum (Barreveld, 1993). Currently, appropriate management and optimal process is not used. It seems that residues and wastes of date palm trees can be used as culture media for soilless systems in greenhouse or it can be applied to soil as organic fertilizer to improve soil chemical and physical condition. This will also decrease the adverse effect of burning these wastes to the environment, the disposal method currently used for date palm wastes. The objective of the present research was to study the combinational effect of organic (date palm wastes and perlite on the yield and quality of greenhouse cucumber.

MATERIALS AND METHODS

This research was carried out in a research greenhouse of Islamic Azad University, khorasgan branch, using a completely randomized design with seven treatments and seven replications. The treatments were different culture media including perlite, date palm waste, soil, perlite + soil (w/w= 5/95), perlite + soil (w/w = 10/90), date palm waste + soil (w/w=5/95) and date palm waste + soil (w/w= 10/90). *Cucumis sativus* (Nasim cultivar) was used as the test plant.

Seeds were planted in peat moss and were transferred to 10 L pots filled with the above culture media. Average temperature of day and night were 30 and 18°C, respectively. Relative humidity was 37.1 to 61.2% during the growth period. Pots were fertigated with Papadopolus nutrient solution (Papadopolus, 1991, 1994; Benton Jones, 2005) which adjusted its pH until 5.5 to 6. According to plant water requirement, irrigation interval was done for one to three times per day.

Physiochemical characteristics of the culture media including bulk density, total porosity, water holding capacity (WHC) and CEC were measured (Baruah and Barthakur 1998; Rhoades 1982, 1988; Walkley and Black, 1934). EC and pH were measured in extraction with 1:2 ratio. Plant growing period was four months and selected growing indices including stem diameter, height of plant, dry mass of shoots, dry mass of roots, TSS of fruit, number of fruits, leaf area index, fruit stiffness index, leaf chlorophyll and fruit yield were measured at the end of the growth period. Data were analyzed using SPSS statistical software and Duncan's multiple range test was used for comparison of treatment means when F values were significant at $p<0.05$.

RESULTS AND DISCUSSION

Substrates properties

Some physiochemical properties of substrates are presented in Table 1. The soil texture was sandy loam and its bulk density was higher than other substrates. Amount of bulk density in palm waste was minimal (0.04 g/cm^3), therefore root media aeration in this treatment was better than for others. Porosity percentage that is, an index for root media aeration was high for palm peat substrate (86%) and it was low for soil (37%). When root media aeration is sufficient, supply of water and nutrient elements for plants is easy. Amount of EC in soil was more than other substrates and this term in perlite was

Table 1. Comparison of physiochemical properties of culture media.

Substrate	BD (g/cm^3)	Porosity (%)	WHC (%)	EC (ds/m)	pH	CEC (Cmol/kg)	N (ppm)	P (ppm)	K (ppm)	Ca (ppm)	Mg (ppm)
Palm waste	0.04	86	92	1.3	6.7	95	310	18.7	50.9	30	25
Perlite	0.32	48	30	0.4	6.9	13.0	248	2.6	8.2	20	6.3
Soil	1.25	37	78	2.3	7.1	43.1	232.5	34.0	4.3	96.3	19.8

BD, Bulk density; WHC, water holding capacity; EC, electrical conductivity; CEC, cation exchange capacity.

Table 2. Some growing indices of cucumber cultivated in different media.

Media	Fruit yield (kg)	Fruit number	Biomass (g)	Plant height (cm)	Root weight (g)
Pa+S(w/w=5/95)	10.34^{d}	125^{e}	42.45^{b}	230.33^{b}	2.08^{b}
Pa+S (w=10/90)	9.14^{e}	114f	39.76^{b}	261.57^{b}	1.66^{b}
Pe+S(w/w=10 /95)	13.32^{c}	165^{c}	42.25^{b}	230.71^{b}	1.42^{b}
Pe+S(w/w=0/90)	13.01^{c}	156^{d}	41.08^{b}	239.85^{b}	1.94^{b}
S (100%)	13.1^{c}	158^{d}	43.92^{b}	252.71^{b}	1.76^{b}
Pa (100%)	27.72^{a}	326^{a}	83.19^{a}	323.14^{a}	3.33^{a}
Pe (100%)	24.32^{b}	287^{b}	45.94^{b}	233.71^{b}	3.36^{a}

Pa, Date palm waste; Pe, perlite; S, soil.

lower than others but according to amount of leaching requirement (20%), it seems that difference in EC of substrates had no important effects. The amount of CEC in substrates were very different with higher and lower amounts related to palm waste and perlit media, respectively, therefore the palm waste media had more capacity for supplement of nutrient elements for plant. The available nitrogen, potassium and magnesium in date palm waste were higher than for other substrates, but the concentration of Ca and P in the soil was more than for other media because this soil was calcareous and Ca concentration was very high and so the soil used in this study was sub cultivated and fertilized previously with phosphorus fertilizer. Mohammadi Ghehsareh et al. (2011), Mohammad Khiyami et al. (2008), Borji et al. (2010) and Alifar et al. (2010) had similar results on palm waste and perlite.

Growing indexes of plant

Some growing indices of cucumber plant are presented in Tables 2 and 3. The amount of cucumber yield in different substrates had significant differences at 5% level. The higher amount of fruit yield related to palm waste media had significant difference with other treatments. The amount of cucumber yield in palm waste was near the perlite media but they had significant difference. Amount of bulk density, porosity, WHC and CEC in date palm waste were maximal as compared with other media. Also, the amount of these physiochemical properties in perlite media was lower than palm waste but these properties were more than soil media. Consequently, plant growth and fruit yield in date palm waste and perlite was more than for soil media. It seems that these physiochemical properties affected plant growth and fruit yield. These results are similar to Olympious (1992) and Kumar and Goh (1999) views about effect of physiochemical properties of media on plant growth and yield. Results of Mohammadi Ghehsareh et al. (2011) on tomato show that fruit yield in date palm and perlite media had no significant difference at 5% level. Alifar et al. (2010) also showed that substrates which include peat, coco peat and perlite had no significant difference on cucumber yield.

Although addition of palm waste and perlite to the soil caused improvement of physiochemical properties of media, but the amount of cucumber yield in palm+soil (w/w= 10/90) media was lowest and it was lower than for soil media and so perlite+soil treatments were similar to soil media. These results may be related to micro organism population in different substrates because micro organism population in the soil, palm waste and perlite before cultivation were 830×10^{7}, 490×10^{7} and not distinguishable, respectively. Micro organism population in the soil was higher and when mixed with organic matter (palm waste), activity of micro organism for organic matter mineralization increased and caused

Table 3. Some growing indices of cucumber cultivated in different media.

Media	SD (cm)	LAI (cm^2)	Chl (%)	FSI (kg/cm^2)	FL (cm)	TSS (brix%)
Pa+S (w/w=5/95)	0.9^{ab}	227.9^{bc}	50.1^{b}	2.16^{a}	13.6^{a}	3.8^{a}
Pa+S (w/w=10/90)	0.9^{b}	240.0^{b}	46.7^{bc}	2.06^{ab}	13.8^{a}	3.7^{ab}
Pe+S (w/w= 5/95)	0.9^{b}	224.1^{bc}	40.6^{bc}	2.03^{ab}	13.3^{a}	3.7^{ab}
Pe+S (w/w=10/90)	0.9^{b}	161.2^{d}	44.9^{bc}	2.14^{ab}	13.7^{a}	3.2^{ab}
S (100%)	1^{ab}	223.5^{bc}	35.9^{c}	1.71^{b}	13.8^{a}	3.4^{ab}
Pa (100%)	1.1^{a}	290.3^{a}	$49.\ 8^{b}$	2.25^{a}	12.7^{b}	3.1^{b}
Pe (100%)	0.8^{b}	192.4^{cd}	63.6^{a}	2.39^{a}	13.2^{a}	3.2^{ab}

SD, Stem diameter; LAI, leaf area index; Chl, chlorophyll; FSI, fruit stiffness index; FL, fruit length; TSS, total solution solid; Pa, date palm waste; Pe, perlit; S, soil.

competition between plant roots and micro organism for nutrient elements adsorption. These process led to decrease in fruit yield and number of fruit in palm+soil (w/w= 10/90) media.

The higher amount of plant biomass in dry condition related to palm waste had significant difference at 5% level with other substrates. The amount of plant height in the palm waste was very high and significantly different with other treatments but other treatments had no significant difference at 5% level. These results may be related to sufficient physicochemical condition in palm waste that was affected by better supplement of water and nutrient elements for plant. The results for comparison of means of the root weight in dry condition showed that high amount of root weight related to palm waste and perlite media had significant difference at 5% level relative to other soil treatments. The roots of cucumber plant grew up properly in the palm waste and perlite because the porosity and bulk density in these media was maximal and minimal, respectively as compared with other treatments and therefore resistance of these substrates to root motion in the media was minimal. Stem diameter of cucumber plant in palm waste media was more than for other substrates (18 mm) and had significant differences at 5% level as compared with other media and so comparison of means show that results of plant height were similar to stem diameter results. Sufficient conditions with a view to bulk density and porosity in palm peat media caused good support of water and nutrient elements for plant leading to good growth (Olympious, 1992; Kumar and Goh, 1999). The leaf area index in date palm waste was maximal and had significant difference at 5% level relative to other treatments. The low amount of leaf area index relates to Pe+s (w/w=10/90) substrate. The amount of chlorophyll in the perlite media was higher and had significant difference with other treatments and so soil substrate had the lowest amount of chlorophyll. Amount of fruit stiffness in date palm waste, perlite and Pa+s (w/w= 5/95) media were higher and had significant differences with other treatments. The fruit length in all treatments except date palm waste was similar and had significant difference with date palm waste at 5% level. Maximal and minimal amount of TSS was related to Pa+s (w/w= 5/95) and date palm waste, respectively and the amount of TSS in cucumber fruit in date palm waste and perlite media had no significant differences. These results are similar to Mohammadi Ghehsareh et al. investigation (2011). Also, Javanpour et al. (2005) studied the effect of combination of some substrates such as perlite and compost with soil for tomato plant and their results show that quality and quantity of tomato in the different substrates had no significant differences. Also, Tzortzakis and Economakis (2008) showed that higher yield, higher total number of fruits per plant, fruit weight, fruit firmness, total soluble solid, titrable acidity and ascorbic acid of tomato is obtained from plants grown in organic media (maize) as compared with inorganic media such as pumice and perlite substrates.

Nutrient elements uptake

The results of comparison means for the concentration of nutrient elements in the leaves of cucumber plant are shown in Table 4. Comparison of means showed that the concentration of nitrogen in plant leaf in Pa+S (w/w=10/90) and Pe+S (w/w=5/95) media were highest and lowest content, respectively but the concentration of P, K and Ca in plant leaf in all substrates had no significant difference. The concentration of Mg in plant leaf grown in Pa+S (w/w=10/90) and Pe+S (w/w= 5/95) substrates were of lower content and had significant differences as compared with other treatments at 5% level. These results may be related to buffer capacity of Mg and its concentration in different substrates. The concentration of Fe, Mn and Zn in plant leaf in perlite media was higher than for other treatments.

Table 4. The concentration of nutrient elements in cucumber leaf in different substrates.

Media	N (%)	P (mg/kg)	K (mg/kg)	Ca (mg/kg)	Mg (mg/kg)	Fe (mg/kg)	Mn (mg/kg)	Zn (mg/kg)
Pa+S (w/w = 5/95)	0.06^{bc}	21.12^{a}	67.9^{a}	10^{a}	41.7^{a}	0.89^{b}	0.04^{c}	0.09^{b}
Pa+S(w/w =10/90)	0.13^{a}	22.16^{a}	60.2^{a}	13.3^{a}	17.7^{b}	0.81^{b}	0.02^{c}	0.05^{c}
Pe+S(w/w= 5/95)	0.04^{c}	17.2^{a}	45.7^{a}	15^{a}	19.3^{b}	0.85^{b}	0.03^{c}	0.08^{b}
Pe+S(w/w = 10/90)	0.05^{bc}	16.26^{a}	39.8^{a}	16.7^{a}	30.2^{ab}	0.81^{b}	0.02^{c}	0.07^{bc}
S (100%)	0.12^{ab}	20.75^{a}	64.6^{a}	16.7^{a}	33.1^{ab}	0.85^{b}	0.02^{c}	0.08^{b}
Pa (100%)	0.05^{bc}	23.95^{a}	58.9^{a}	13.3^{a}	36.4^{ab}	0.73^{b}	0.92^{b}	0.07^{bc}
Pe (100%)	0.09^{abc}	24.72^{a}	68.1^{a}	10.5^{a}	29.1^{ab}	1.12^{a}	1.55^{a}	0.14^{a}

Pa, Date palm waste; Pe, perlit; S, soil.

Mohammadi Ghehsareh et al. (2011) showed that the media which include perlite and date palm peat had no significant effect on concentration of nutrient elements in tomato fruit such as N, P, K and Alifar et al. (2010) showed that organic and inorganic substrates had no significant difference on concentration of macro and micro elements in the leaf of cucumber.

Conclusion

The results of this investigation show that plant growing indices for cucumber when cultured only in date palm waste and perlite substrates were sufficient and when the materials especially date palm waste was added to the soil, although they caused amendment of physiochemical property of media, the plant growing indices decreased. It seems that when organic waste is mixed with soil, the activity of micro organism population in rhizosphere can have effect on plant activity so that the effect of physiochemical property of media is amended with mixing neutralized. Therefore, in mixing process with soil, we propose that the use of date palm waste be used to complete its fermentation and composting process.

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