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Full Length Research Paper

Influence of different levels of garden compost on growth and stand establishment of tomato and cucumber in greenhouse circumstance

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Garden compost was mixed with a peat-based growing media (Kimia, Pardis Production and Iran) at rates of 0, 10, 20, 40, 60 and 100% by volume. Garden compost increased electrical conductivity (EC) and pH of soil in the pots, which were slightly higher than the acceptable EC and pH ranges. Cucumber and tomato seeds were planted in complete randomized design with 10 replications. Different substrate combinations had significant effect on transplant characteristics. The best qualities of tomato and cucumber transplant such as plant growth, root growth, dry matter and leaf chlorophyll content were obtained from 60 and 100% compost treatments, respectively. The mean comparison between 100% compost and 100% peat treatments indicated no remarkable differences among them. Therefore, garden compost can be replaced with peat or it can be used in mixtures for seedlings production and transplanting of tomato and cucumber.

Key words: Seedling, chlorophyll content, dry matter, vegetable production.

INTRODUCTION

In Iran, sphagnum peat is widely used as the main substrate component for the production of vegetable seedling in containers. In recent years, environmental pressures on peat extraction and cost of peat have escalated. Therefore, other inexpensive organically based materials are being evaluated and used as total or partial peat substitutes in vegetable nursery production systems. As observed (Cull, 1981; Raviv et al., 1986; Morel et al., 2000; Abad et al., 2001), composts obtained from different organic materials were introduced as promising peat substitutes (Verdonck, 1988; Bugbee and Frinck, 1989; Garcia-Gomez et al., 2002; Sanchez-Monedero et al., 2004; Ribeiro et al., 2007). However, some of the compost types used had salinity (Ribeiro et al., 2000; Castillo et al., 2004), unsuitable physical properties (Ribeiro et al., 1999), and variable quality and composition of substrate (Vavrina, 1995; Hicklenton et al., 2001), which are pointed out as limiting factors. As a result, each compost type has to be tested to find the best amounts of composted materials for improvement of transplant growth. The aim of this study was to evaluate the quality of a composted material obtained from garden wastes and cow manure as a substrate or as substrate component for vegetable seedling production. To achieve this goal, tomato and cucumber were used as indicator plants.

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MATERIALS AND METHODS

The experiment was carried out in the Horticulture Department of Young Researchers Club and Islamic Azad University (Jahrom Branch), Jahrom, Iran, during May 30th, 2007 to April 27th, 2008. Locally available compost (garden compost, Shiraz) obtained from

Table 1. Some chemical properties of the substrates.

Substrate	EC ($dS.m^{-1}$)	pH	O.C (%)	N (%)	C/N	P (%)	K (%)
Peat[1]	3.0	6.3	37.7	4.0	9.42	0.4	2.0
Compost[2]	3.5	7.1	67.3	5.1	13.19	0.64	0.76

[1]Enriched peat moss (Kimia, Pardis Production, Iran); [2]Garden compost.

Table 2. Electrical conductivity (EC), pH and moisture percent in different substrates.

Substrate	EC ($dS.m^{-1}$)	pH	Moisture (%)
Control	3.00[c1]	6.20[d]	60.1[a]
10% C[2]	3.25[b]	6.45[cd]	58.3[a]
20% C	3.35[b]	6.55[bc]	52.9[b]
40% C	3.41[ab]	6.68[b]	50.4[b]
60% C	3.45[a]	6.70[ab]	48.2[b]
100% C	3.50[a]	7.10[a]	39.1[c]

[1]Means with similar letters in each column are not significantly different at 1% level of DMRT; [2]compost.

shredded garden wastes (mainly fig and grape trees) mixed with cow manure in proportion of 8:1 (Dickerson, 2005) was tested. Composting process took place in aerated piles (3 m length, 1.5 m width and 1 m height) over 9 months. Garden compost was mixed with a commercial enriched peat moss (Kimia, Pardis Production, Iran) at rates of 0, 10, 20, 40, 60 and 100% compost by volume.

Both substrates (garden compost and peat moss) were sampled and their main chemical properties were characterized (Table 1). Electrical conductivity (EC) and pH of mixtures were measured in the water extract (1:6 by volume) according to Johnson (1980). Percent moisture was determined by drying a known weight of water-saturated media at 105°C (221F) for 24 h and weighing afterwards. Total C and N concentrations were determined by a CNS analyzer (Carlo- Erba NA-1500; BICO, Burbank, Canada). Compost samples were oven dried for 2 days (60°C; 140F) and ground to powder with a ball grinder before combustion. Phosphorus was determined by v*anadomolybdophosphoric* acid colorimetric method and K was determined by flame photometer. The value of pH, EC and percent moisture in six different substrate combinations were statistically analyzed. Cucumber (*Cucumis sativus* L. cv. Sina) and tomato (*Lycopersicum esculentum* Mill. cv. Cardelen) seeds were planted in complete randomized design with 10 replications in February, 2008. Plants were grown in transplant containers (350 ml) in a Quonset greenhouse with mean minimum and maximum temperatures of 22 and 35°C (72 and 95F), respectively. Germination uniformity (GU) was calculated using the equation:

$$GU = D90 - D10$$

D90: time duration to reach 90% of maximum germination; D10: duration to reach 10% of maximum germination.

Chlorophyll content was measured in 3rd and 4th true leaves of each plant, using a Spad-502 meter (Spectrum Technologies Inc., Plainfield, IL). Leaf number of both species was determined by counting the number of true leaves per plant at the end of the experiment. Cucumber and tomato seedlings were harvested 8 and 7 weeks, respectively, after sowing. Main stem length was measured from the shoot apex of the stem to the crown. Fresh seedlings were grounded through a 1 mm screen. Shoots were severed at the crown and roots were hand washed thoroughly. Shoot and root material were dried at 65°C for 48 h and ground through a 1 mm screen. Root volumes (cm^3) were measured by the method of submerging root into a measuring cylinder with water. Data were subjected to ANOVA analysis, followed by the Duncan's multiple range test at $\alpha<0.01$.

RESULTS AND DISCUSSION

Chemical characteristics and nutrient composition of media

Comparison between some chemical elements of both substrates (garden compost and peat moss) showed statistical differences in nitrogen and phosphorus (Table 1). In garden compost, potassium was lower than peat moss, while the organic matter content was higher. The low carbon/nitrogen (C/N) ratio of the compost indicated that the compost was stable and mature (Jervis et al., 1996) (Table 1). Composts with C/N ratios less than 20 are optimal for plant production. C/N ratios greater than 30 may result in phytotoxicity symptoms and possible plant death (Davidson et al., 1994).

Compost addition significantly increased electrical conductivity (EC) of the substrates (Table 2). Previous studies with composts from different sources, showed that salinity is a limiting factor for their use as a substrate component (Ribeiro et al., 2000; Castillo et al., 2004; Sanchez-Monedero et al., 2004). In this experiment, EC values of control (peat moss) and 100% compost were 3 and 3.5 $dS.m^{-1}$, respectively. However, the optimum EC values ranges for substrates were defined as less than

Table 3. The assessment of some biometric indices of tomato seedlings in different substrates

Substrate	GU (day)	Leaf number	Plant Height (cm)	Shoot fresh weight (g)	Shoot dry weight (g)	Root dry weight (g)	Root volume (cm^3)	Chlorophyll (Spad units)
Control	4.6^{a1}	3.0^{b}	10.9^{d}	63.8^{c}	4.5^{c}	0.64^{b}	8.8^{b}	42.6^{d}
10% C[2]	4.8^{a}	3.8^{ab}	11.3^{cd}	60.7^{d}	4.7^{bc}	0.66^{b}	9.8^{a}	44.6^{c}
20% C	4.8^{a}	4.1^{ab}	11.7^{cd}	65.9^{bc}	4.9^{bc}	0.70^{b}	9.9^{a}	46.3^{b}
40% C	5.4^{a}	4.7^{a}	12.5^{bc}	67.8^{ab}	6.1^{ab}	0.77^{ab}	10.5^{a}	47.5^{ab}
60% C	5.4^{a}	4.9^{a}	13.5^{ab}	68.4^{a}	6.4^{a}	0.85^{a}	10.9^{a}	48.9^{a}
100% C	4.5^{a}	3.7^{ab}	14.5^{a}	64.1^{c}	6.5^{a}	0.70^{b}	11.2^{a}	50.1^{a}

[1]Means with similar letters in each column are not significantly different at 1% level of DMRT; [2]compost.

Table 4. The assessment of some biometrics indices of cucumber seedling in different substrates.

Substrate	GU (day)	Leaf number	Plant height (cm)	Shoot fresh weight (g)	Shoot dry weight (g)	Root dry weight (g)	Root volume (cm^3)	Chlorophyll (Spad units)
Control	4.9^{b1}	3.0^{c}	13.3^{d}	56.5^{b}	2.9^{c}	0.35^{d}	11.9^{b}	44.2^{d}
10% C[2]	5.3^{b}	3.1^{bc}	13.9^{cd}	56.9^{b}	3.4^{c}	0.36^{cd}	12.2^{b}	45.9^{c}
20% C	6.8^{a}	3.3^{bc}	14.4^{bcd}	56.9^{b}	3.7^{c}	0.38^{bcd}	12.4^{b}	48.1^{b}
40% C	6.9^{a}	3.7^{abc}	14.6^{abc}	57.0^{b}	3.9^{bc}	0.39^{abc}	13.9^{b}	49.1^{b}
60% C	6.9^{a}	4.0^{ab}	15.7^{a}	59.5^{a}	4.8^{b}	0.40^{ab}	14.6^{b}	50.8^{b}
100% C	7.2^{a}	4.4^{a}	15.1^{ab}	59.1^{a}	5.9^{a}	0.42^{a}	16.9^{a}	55.6^{a}

[1]Means with similar letters in each column are not significantly different at 1% level of DMRT; [2]compost.

0.5 $dS.m^{-1}$ (Abad et al., 2001). Compost addition significantly increased pH values of substrates, which were slightly higher than the acceptable pH range (5.3 to 6.5) (Abad et al., 2001). Moisture percent was higher for control (peat moss) and decreased significantly with increasing compost rates. Reduction of moisture percent with compost addition to peat-based substrate was also reported in other studies (Sanchez-Monedero et al., 2004; Ribeiro et al., 2007).

Tomato seedling growth

Substrates showed significant differences in most biometric indices, except for germination uniformity (GU) and leaf number (Table 3). By increasing the compost rate in mixtures, the height of tomato seedling increased significantly. The highest shoot fresh weight of seedlings was obtained in 60% compost. There were no significant differences between the results from control (peat moss) and 100% compost. The shoot dry weight of seedlings grown on control (peat moss) was 30% lower than those from 100% compost. There was no significant difference between the result from 60 and 100% compost. The highest root dry weight of seedlings was obtained in 60% compost, followed by 40% compost. There were no significant differences between the results from control (peat moss), 10, 20 and 100% compost. The lowest root volume for tomato was observed in the control (peat moss), while this characteristic for the plants from 10, 20, 40, 60 and 100% compost showed no significant differences. Chlorophyll content increased by increasing compost rate in substrates. This result indicates that garden compost was considered stable and mature (C/N ratio = 13.9) and it may have had sufficient supply of available nutrients for plant uptake, resulting in higher SPAD readings.

Cucumber seedling growth

Substrates showed significant differences at the assessment of all the biometrics indices in cucumber plant growth (Table 4). The lowest germination uniformity (GU) was observed in the control and 10% compost, while there were no significant differences between the results from other substrates. By increasing compost rate in substrates, the number of leaves increased (Table 3). The highest number of leaves per plant was obtained in 100% compost, followed by 60, 40, 20, 10% and control (peat moss). The differences between them were comparatively small. Plant height was significantly affected in different substrates. The highest plant height was obtained in 60% compost and the lowest one in peat moss (control). The lowest shoot fresh weight of seedlings was obtained in 60 and 100% compost. There were no significant differences between the result from control, 40, 20 and 10% compost. The cucumber seedlings grown on control (peat moss), 20 and 10% compost had the least shoot dry weight of all substrates (Table 3). The highest shoot dry weight of seedlings was obtained in 100% compost, followed by 60 and 40% compost. The highest root dry weight of seedlings was obtained in 100% compost, followed by 60 and 40% compost. There was no significant difference between the result from control (peat moss), 10 and 20% compost. The highest volume of root for cucumber was observed for 100% compost, while there was no significant difference between the results from control, 10, 20, 40 and 60% compost. The effect of compost addition on chlorophyll content of cucumber showed the same tendency with tomato; chlorophyll content increased with increasing compost rate in substrates. Obviously, the presence of highly active organic matter from garden compost accelerates development of the plants. Similar results have been reported by several authors (Reis et al., 1998; Reis and Coelho, 2007; Ribeiro et al., 2007; Diaz-Perez et al., 2008).

Conclusions

Based on the results, all the substrates, even the peat moss (Kimia, Pardis Production, Iran) EC values were higher than the optimum range (>0.5 $dS.m^{-1}$) (Abad et al., 2001). However, the growth of vegetable seedlings was not affected by the presence of garden compost. Bernstein (1975) indicated that high salinity (>3.5 $dS.m^{-1}$) typically has adverse effects on the success and rate of seed germination and on the growth and development of seedlings. Therefore, the EC (3 to 3.5 $dS.m^{-1}$) in present study has no remarkable effect on seedling growth. Relatively weak growth of tomato and cucumber seedlings was observed in control (peat moss). The seedling grown on 60 and 100% compost, respectively were stronger than those from other substrates.

According to the results of this experiment, garden compost can be used as a substrate for tomato and cucumber seedlings production, being an alternative to peat based substrates which are usually used.

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