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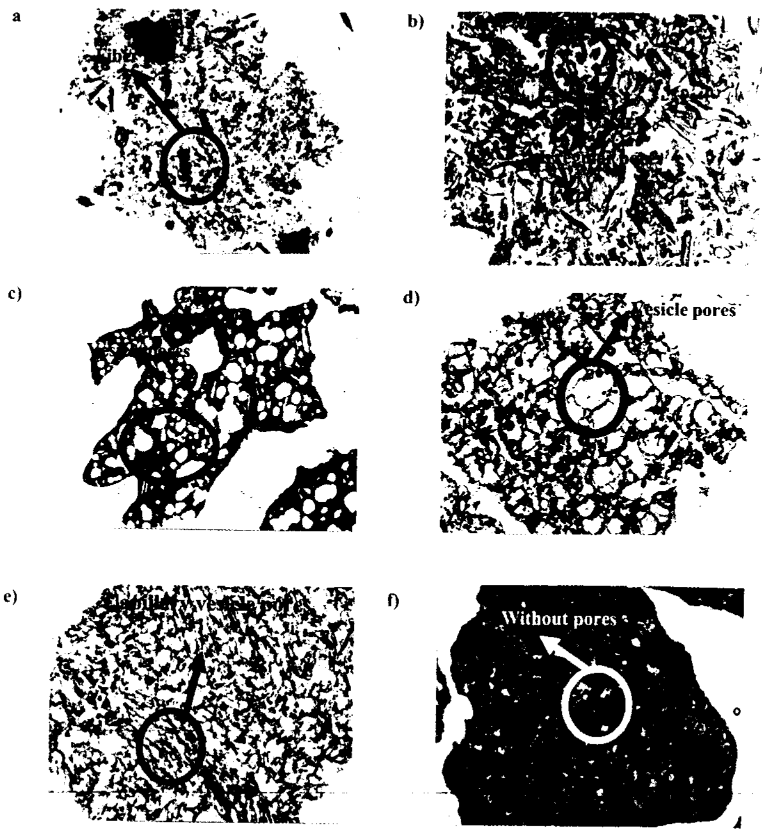

Fig. 4. Type of pores in different materials in particles higher than 3.35 mm. a) coconut fiber, b) *Sphagnum* peat, c) volcanic scoria, d) perlite, e) pumice and f) zeolite. Frame length 5.3 mm, LPP.

Utilization of Zeolite as a Substrate for Containerized Oriental Spruce (*Picea orientalis* L. (Link.)) Seedlings Propagation

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Abstract

This study was designed to investigate influence of different growing media and their mixtures (with zeolite and without zeolite) on seedling morphological characteristics of oriental spruce (*Picea orientalis* L. (Link.)). Eighteen growth media with different volume combinations (%) (7:3, 5:2:3, 6:2:2, 7:2:1, 5:2:2:1) of Barma peat (BP), tea residue compost (CTR), fine pumice (FP), coarse pumice (CP), perlite (P) and zeolite (Z) were prepared as a potting material, then sown with oriental spruce seeds. In this study, irrigation strategies were applied based on observation, and the same fertilization regime was applied to all the media. At the end of the second growing period, 30 seedlings from each treatment with three replications were harvested and measured for height (SH), root collar diameter (RCD), root dry weight (RDW), stem dry weight (SDW) and dry root percentage (DRP). As a result, significant difference was not determined among the treatments as to the SH, RCD, SDW/RDW and DRP. However, significant difference was determined among the growth media as to the RDW and SDW. The maximum SDW was determined for BP (0.5) + CTR (0.2) + CP (0.2) + Z (0.1) medium (3.24 g) while BP (0.6) + P (0.2) + Z (0.2) (1.59 g) medium showed minimum SDW. In addition, the maximum RDW were determined for BP (0.5) + CTR (0.2) + CP (0.2) + Z (0.1) medium (1.82 g) while BP (0.6) + CP (0.2) + Z (0.2) medium (1.01 g) showed minimum RDW. Addition of 20% zeolite to growing media types had a negative effect on the seedling morphological characteristics. Still, natural zeolite could be used as a substrate such as pumice and perlite: Turkey has 45.8 billions of zeolite potential. Therefore, using zeolite in nurseries may reduce the costs of nurseries.

INTRODUCTION

Peat has a long history of use in greenhouse production even though it is not a readily renewable resource. Low-quality degraded peat (≥ H_4 on the Von Post scale) which has small fibers holds larger amounts of water and less air as compare to less degraded peat (Allaire et al., 2005). Puustjärvi (1973) reported that the structure of peat may be too coarse or too fine. However, the most common problem with structure is that it is too fine. In that case, the water space becomes too large and the air space too small. In addition, the stability of physical properties of substrates is of primary concern for container-grown plants because changes in these properties may negatively affect plant growth (Allaire-Leung et al., 1999). Moreover, organic substrates as peat with low homogeneity and high decomposition ratio create pathological problems and cause toxicity (Koksaldi, 1999).

Developing of peat alternative substrates is necessary for three different reasons: the resources of peat are limited; the pressure for using waste coming from human or industrial activities increases rapidly and the economic necessity to use locally produced waste products (Guerin et al., 2001). Substrates quality and stability are related to physical attributes such as particle-size and geometries, pore-size distribution, arrangement, which influence water and gas storage, and exchange properties (Allaire-Leung et al., 1999).

The fertigation techniques normally used in container nurseries are not efficient for the management of nutrients. Moreover, control of substrate fertility potential is

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difficult due to moisture and nutrient variability inside the container and uncertainty of the relationship between the chemical composition of substrate and nutrient status of plants (Lemaire et al., 1995). The reasons behind these difficulties are: (1) seedlings grow in such a small containers that little change in physical (porosity etc,) and chemical (pH, EC, etc.) properties of growing media could easily influence their growth and (2) low or moderate biostability of organic substrates. The organic substrates with moderate or low biostability will release available nutrients and vary in their chemical properties such as pH, electrical conductivity (EC) and cation exchange capacity (CEC) as a consequence of the decomposition of the substrate's organic matter (Lemaire, 1997). Consequently, peat substrates are routinely amended with various materials such as large-particle-size perlite, rockwool, expanding clay, sand, wood bark, compost, polystyrene and polyurethane to obtain air filled porosity (Nkongolo and Caron, 1999).

Zeolites, a naturally occurring mineral group consisting about of 50 mineral types, draw attention as a good growing medium substrate for a long period due to its good physical and chemical characteristics (Markovich et al., 1995). They have a rigid three-dimensional crystal structure with voids and channels of molecular size and high cation exchange capacity (CEC) arising from substitution of Al for Si in the silicon oxide tetrahedral units that constitute the mineral structure (Pickering et al., 2002; Ayan, 2001, 2002a). Zeolite has many good features that make it very attractive for nursery use as a growing media compared to other growing media types such as perlite, pumice and river sand. Some of these features are: (1) it has high ammonium absorption capacity; (2) it retains water and nutrients; (3) it slowly releases N and P into soil as slow release fertilizers do (Koksaldi, 1999).

Turkey has 45.8 billion tons of zeolite potential (Ayan, 2001). Therefore, using zeolite in nurseries will be economical. However, there is lack of information about the zeolite effects on growth of seedlings, and the ratios to be mixed with other growing media types in pots. The objectives of this research were designed (1) to investigate influence of different growing media and their mixtures (with zeolite and without zeolite) on seedling morphology of oriental spruce (*Picea orientalis* (L). Link.), (2) to compare the effect of zeolite with that of perlite and pumice as an additive material in growing media.

MATERIALS AND METHODS

The study was carried out in a Forest Nursery in Of, Trabzon, Turkey (Altitude: 5 m) with seedlings of oriental spruce which is the nature and paleoendemic species of Turkey and is naturally distributed approximately on 350,000 hectares (Küçük, 1989) and used as commercial forest tree. Approximately 93,000 ha of the oriental spruce pure stands are subject to artificial regenerated and 140,000 ha of mixed stands are subject to planted (Genç, 1995).

Barma peat (BP / 1–3 mm), tea residue compost (CTR), perlite (P), fine pumice (FP / 2–4 mm) coarse pumice (CP / 4–8 mm) and natural zeolite (Z / Dust-size) were used as potting media. Peat was taken from Barma plateau at 1800 m altitude in Caykara-Trabzon. These growing media types were chosen because they provide better aeration and water permeability in pots and absorb nutrients. Eighteen different volume combinations (%) (7:3, 5:2:3, 6:2:2, 7:2:1, 5:2:2:1) of these six different potting media with and without zeolite were established and used as potting material (Table 1).

BP was used as main additive material in pots. It had 22% of air capacity, 60% of water holding capacity and 88% of total porosity. Electrical conductivity of this material was 0.93 mS/cm, and pH was between 4.9 and 6.0, because the used BP has heterogenic characters. It was mainly sphagnum type with small amount of grass mixture. Salt and lime contents were close to zero. Cation exchange capacity was between 49 to 76 meq/100 g. It was classified as H_1-H_3 quality class peat according to Von Post scale.

Nevşehir originated pumice consisted of 60–75% of SiO_2, 13–15% of Al_2O_3, 1–3% of Fe_2O_3, 1–2% of CaO, 1–2% of MgO and 7–8% of Na_2O-K_2O. It also had very low amount of TiO_2, SO_3, Cl and its pH ranged from 7 to 7.5 with very low salt content.

The chemical composition of Manisa-Gördes originated natural zeolite was 71.29% of SiO_2, 13.55% of Al_2O_3, 1.15% of Fe_2O_3, 3.50% of K_2O, 5.90% of H_2O, 1.96% of CaO, 0.70% of MgO, 0.60% of Na_2O, 0.02% of Ti,0.04% of Ag and 30 ppm of B. In this study zeolite dust was preferred to the experimental design because of high nutrient absorption capacity. This character is very valuable especially in the humid regions.

The C/N ratio as 6.69–14.52, total P (ppm) as 17798–12780, exchangeable P (ppm) as 5489–2148, total nitrogen (%) as 3.72–1.753, total water capacity (%) as 679.00–544.71, organic matter (%) as 42–807–43.785 were determined in the analysis applied to the CTR after having been composted for 10–12 months. Also, the richness of exchangeable and total Mn^{++}, Al^{+++} and Fe^{++} microelements in the CTR were determined (Altun, 1988).

Cultural Treatments and Production Stage

Seeds from Kapıköy provenance of Maçka-Trabzon were sown into 28 containers whose dimensions are 32 x 45 x 10 cm (width x length x depth) (Enso-Finland Model Type) on March 5, 1999 using a sowing machine. Three seeds were sowed into the each pot. The seedlings were thinning after 2 months by leaving one seedling in the each pot. In all media, sufficient numbers of seedlings were obtained, and among the media no differences were observed. Seedlings were kept in greenhouse for two months after sowing. Later, they transferred into a shaded area for approximately one year for acclimatization before letting them outdoor conditions. Seedlings were kept in outdoor conditions until the end of the second growing period.

Fertilization

Fertilizer applications were done following the recommendations of Richard and McDonald (1979) for pH, nitrate and EC of growing media. Different fertilizers were applied depending on timely pH, nitrate and EC measurements of growing media types (Table 2).

Physical Characteristics of the Media

Before seed sowing and fertilization, growing media samples were analysed for their physical properties (Table 1). To determine water holding capacity (%) 500 cm^3 samples were taken and put under 1 g/cm^3 pressure before wetting them in a tray for one night. After that, samples were oven-dried at 105°C for 24 hours and weighed. Specific gravity was determined according to picnometer method. Porosity was calculated using the following formula: Porosity (%) = [(Specific gravity – bulk density)] x 100 / Specific gravity. Air content was estimated as follows: Air content (%) = porosity (%) – water holding capacity (%). Organic matter content was determined by wet digestion (modified Walkley-Black Procedure) method (Kalra and Maynard, 1991).

Seedling Measurements

The seedling roots extracted from the pot after cutting at root collar were washed and oven-dried at 105°C for 24 hours and weighed to nearest 0.001 g. Thirty seedlings per treatment were sampled and measured for height (SH), root collar diameter (RCD), root dry weight (RDW) and stem dry weight (SDW) at the end of second vegetation period. SDW / RDW ratio obtained by calculating.

Experimental Design and Data Analysis

Experiment was arranged in a completely randomized block design with three replications for each treatment. Totals of 18 treatments were randomly assigned into each block. Thirty seedlings per treatment were sampled in each sampling time. The growing media were formulated from binary, ternary and quartet of seven materials.

Data were subjected to one-way analysis of variance (ANOVA). Variables were tested for normality and homogeneity of variances and transformations were made when necessary to meet the underlying statistical assumptions of ANOVA. All pair wise comparisons of individual means were done by the least significant differences (LSD) *t*-test at ($P < 0.05$ level). Relationships between growing media properties and seedling morphological parameters were tested using correlation analyses.

RESULTS AND DISCUSSION

The average for three replications and F values of SH, RCD, SDW, RDW, SDW/RDW and RP for each growing media are given in Table 3.

Seedling Height (SH) and Root Collar Diameter (RCD)

No significant differences were found in SH and RCD among treatments (P<0.001) (Table 3). General mean of the SH and RCD are 11.58 cm, 4.44 mm, relatively in zeolite additive media while 12.19 cm, 4.6 mm in none-zeolite media. But, SH values in this study were significantly lower than values by Ayan (2002b) and Ayan and Bahadır (1995). RCD values were close to values observed by Ayan (2002b) and significantly higher than values by Ayan and Bahadır (1995). The low SH values in this study can be explained with inadequate air capacity (minimum 8% - maximum 17%) in the growing media. De Boodt and Verdonck (1972) stated that a growing media for perfect growing condition must have both 20–25% of air volume and 20–30% of available water capacity at the same time. Aslan (1998) reported that sizes of aggregates in the growing media significantly affected the root and stem growth of seedlings. Similarly, pore spaces of growing media could be negatively influenced by the dust-size zeolite used in this study. This could be a reason for explaining no positive effect of zeolite on SH parameter. Similar reports have been made by Köksaldi (1999) and Tuzuner and Timay (1984).

As shown in Table 3, there is no significant difference between the zeolite additive and none-zeolite media as to the SH and RCD. So, zeolite can be used instead of the other additive materials as CP and FP. In the third and sixth groups media, in which zeolite compared with perlite, 10% volume mixture of the zeolite showed effect as P, but 20% volume mixture of the zeolite showed negative effect on SH. On RCD, both 10% and 20% volume mixture of the zeolite showed effect as FP, CP and P. Consequently, zeolite can be used as these widely known and used additive materials (Table 3).

Stem and Root Dry Weight (SDW, RDW)

SDW ($P < 0.05$) and RDW ($P < 0.01$) differed significantly with growing types. The highest SDW value (3.24 g) observed in the BP + CTR + CP + Z (5:2:2:1) growing media while the lowest value (1.59 g) observed in BP + P + Z (6:2:2) growing media. The maximum value of the SDW observed in 10% volume mixture of zeolite, while the 20% volume mixture of zeolite reduced the SDW value at significant degree. Besides, the highest RDW value determined in the BP + P (7:3) and BP + CTR + CP + Z (5:2:2:1) media as 1.87 g and 1.82 g, respectively. The lowest RDW value (1.01 g) observed in BP + CP + Z (6:2:2) medium. As SDW, 20% volume mixture of the zeolite affected RDW negatively (Table 3).

Between the zeolite additive and none-zeolite FP, CP media in the first and second groups none-CTR growing media, SDW and RDW values did not show significant difference. Moreover, in the fourth group media with CTR, 10% of zeolite additive to CP showed positive effect. But, in the media (Group 3) in which zeolite used with perlite, 20% of the zeolite additive reduced SDW and RDW values (Table 4).

Dry Stem/Root Ratio (SDW/RDW) and Dry Root Percentage (DRP)

No significant differences were found in SDW/RDW and DRP among treatments. General mean SDW/RDW ratio and DRP were 1.68 g and 37.94% for zeolite added, and 1.63 g and 38.38% for non-zeolite media, respectively (Table 3). Thus, suitable oriental spruce seedlings were propagated in terms of DRP and SDW/RDW parameters in zeolite added media. Generally in this study, it was found higher RP value and more suitable SDW/RDW values than values by Ayan (2002b).

Also, as shown on Table 3, there is no significant difference between zeolite additive and none-zeolite media as SDW/RDW and RP characters. Therefore, zeolite can be used as an additive material instead of CP, FP and P, alternatively.

CONCLUSIONS

As a result of this study, zeolite increased the SDW and RDW morphological characters of oriental spruce, and has more positive effect on SDW and RDW than FP, CP and perlite. Among the Z, FP, CP and P, no significant difference were determined as to SH, RCD, SDW/RDW and RP characters. So, zeolite can be used as these additive materials. But, in medium combinations in which zeolite is used with perlite, 20% of the zeolite additive reduced SH, SDW and RDW values. In brief, as the scots pine seedling propagation (Ayan and Tufekçioğlu, 2006), Manisa-Gördes originated zeolite can be used as an additive material in the propagation of containerised oriental spruce (*Picea orientalis* (L.) Link.) seedlings.

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Tables

Table 1. Volume combinations of growing media used in pots and their initial physical properties.

Growing media symbols	Water capacity (% vol.)	Air capacity (% vol.)	Porosity (% vol.)	Loss of ignition (%)	Specific gravity (g/cm^3)	Organic matter (%)
BP + P (7:3)	75	11	86	69.57	1.32	50.51
BP + FP (7:3)	71	13	84	43.36	1.59	46.10
BP + CP (7:3)	72	9	81	55.98	1.42	69.75
BP + CTR + P (6:2:2)	76	11	87	70.21	1.37	55.21
BP + CTR + FP (6:2:2)	72	13	85	63.34	1.67	57.84
BP + CTR + CP (6:2:2)	74	14	88	65.20	1.52	54.57
BP + CTR + P (5:2:3)	80	9	89	64.23	1.37	48.74
BP + CTR + FP (5:2:3)	74	10	84	49.72	1.59	51.56
BP + CTR + CP (5:2:3)	73	8	81	62.75	1.40	51.77
BP + P + Z (7:2:1)	76	10	86	62.40	1.37	35.10
BP + P + Z (6:2:2)	72	12	84	51.28	1.58	28.79
BP + FP + Z (7:2:1)	77	9	86	60.34	1.61	56.29
BP + FP + Z (6:2:2)	71	11	82	40.39	1.71	52.73
BP + CP + Z (7:2:1)	69	17	86	52.74	1.75	45.44
BP + CP + Z (6:2:2)	69	15	84	51.18	1.77	47.88
BP + CTR + P + Z (5:2:2:1)	74	13	87	46.67	1.63	38.82
BP + CTR + FP + Z (5:2:2:1)	67	13	80	40.00	1.68	41.52
BP + CTR + CP + Z (5:2:2:1)	71	13	84	61.35	1.54	43.74

BP: Barma Peat, P: Perlite, FP: Fine Pumice (2–4 mm), CP: Coarse pumice (4–8 mm), CTR: Tea residue compost, Z: Zeolite (Dust).

Table 2. Application of fertilizers.

Fertilizer	Chemical content	Application time
Superex-9	N 19%+ P 5%+ K 20%+ micro elements	At the beginning of the vegetation season
Superex-5	N 11%+ P 4%+ K 25%+ micro elements	At the middle of the vegetation season
Superex-7	N 0%+ P 16%+ K 20%+ micro elements	Before the end of the vegetation season

Table 3. Mean values and multiple comparisons of some seedling morphological parameters.

Growing media symbols	Seedling morphological character					
	SH[4] (cm)	RCD[4] (mm)	Dry weight			
			SDW[4] (g)	RDW[4] (g)	SDW / RDW[4]	DRP[4] (%)
BP + P (7:3)	13.10 a	4.98 a	3.20 ab	1.87 a	1.76 a	37.2 a
BP + FP (7:3)	11.98 a	4.57 a	2.24 abcd	1.40 abcdef	1.60 a	38.6 a
BP + CP (7:3)	11.90 a	4.67 a	2.16 abcd	1.35 abcdef	1.58 a	38.8 a
BP + CTR + P (6:2:2)	12.77 a	4.68 a	2.22 abcd	1.31 bcdef	1.71 a	36.9 a
BP + CTR + FP (6:2:2)	11.54 a	4.44 a	2.31 abcd	1.54 abcdef	1.51 a	40.0 a
BP + CTR + CP (6:2:2)	11.81 a	4.33 a	1.94 cd	1.09 ef	1.79 a	36.0 a
BP + CTR + P (5:2:3)	10.50 a	4.34 a	2.10 cd	1.45 abcdef	1.45 a	41.1 a
BP + CTR + FP (5:2:3)	12.31 a	4.58 a	2.44 abcd	1.64 abcd	1.49 a	40.3 a
BP + CTR + CP (5:2:3)	13.83 a	4.89 a	2.88 abc	1.64 abcde	1.78 a	36.5 a
Mean	**12.19**	**4.6**	**2.39**	**1.48**	**1.631**	**38.38**
BP + P + Z (7:2:1)	12.39 a	4.39 a	2.46 abcd	1.42 abcdef	1.76 a	36.3 a
BP + P + Z (6:2:2)	9.37 a	4.18 a	1.59 d	1.15 def	1.39 a	42.4 a
BP + FP + Z (7:2:1)	11.22 a	4.30 a	1.94 cd	1.22 cdef	1.58 a	39.1 a
BP + FP + Z (6:2:2)	12.89 a	4.91 a	2.68 abcd	1.72 abc	1.54 a	40.2 a
BP + CP + Z (7:2:1)	13.05 a	4.74 a	2.12 bcd	1.20 cdef	1.72 a	37.6 a
BP + CP + Z (6:2:2)	9.96 a	3.66 a	1.79 cd	1.01 f	1.79 a	35.9 a
BP + CTR + P + Z (5:2:2:1)	10.62 a	4.45 a	1.79 cd	1.15 def	1.56 a	39.2 a
BP + CTR + FP + Z (5:2:2:1)	11.51 a	4.49 a	2.21 abcd	1.10 def	1.95 a	34.4 a
BP + CTR + CP + Z (5:2:2:1)	13.17 a	4.86 a	3.24 a	1.82 ab	1.81 a	36.4 a
Mean	**11.58**	**4.44**	**2.20**	**1.31**	**1.68**	**37.94**
General Mean	**11.88**	**4.52**	**2.29**	**1.39**	**1.65**	**38.16**
F value	**1.677 ns**	**0.918 ns**	**2.010 ***	**2.351 ****	**0.843 ns**	**0.812 ns**

[1] Values are the means of three replications.

[2] For each character, mean values with the same letter are not significantly different at 1% level

[3] ***: significant at $P < 0.001$; **: significant at $P < 0.01$; *: significant at $P < 0,05$; ns: none significant

[4] SH: Seedling Height, RCD: Root Collar Diameter, SDW: Stem dry weight, RDW: Root Dry Wight, DRP: Dry root percentage

Table 4. ANOVA results of zeolite added treatments grouped with treatments without zeolite but same media types (n=18).

Group	Growing media symbols	Seedling morphological character					
				Dry weight			
		SH (cm)	RCD (mm)	Stem (SDW) (g)	Root (RDW) (g)	Stem / root	DRP
1	BP + CP (7:3)	11.90	4.63	1.85	1.35	1.58	38.83
	BP + CP + Z (7:2:1)	13.05	4.74	1.77	1.20	1.72	37.60
	BP + CP + Z (6:2:2)	9.96	3.66	1.98	1.01	1.79	35.90
	F value	**2.568 ns**	**1.244 ns**	**0.051 ns**	**0.741 ns**	**0.308 ns**	**0.256 ns**
2	BP + FP (7:3)	11.98	4.57	1.87	1.40	1.60	38.63
	BP + FP + Z (7:2:1)	11.22	4.30	1.80	1.22	1.58	39.13
	BP + FP + Z (6:2:2)	12.89	4.91	2.57	1.72	1.54	40.17
	F value	**0.501 ns**	**0.764 ns**	**0.666 ns**	**2.801 ns**	**0.026 ns**	**0.086 ns**
3	BP + P (7:3)	13.10 a	4.98	3.02 a	1.87 a	1.76	37.20
	BP + P + Z (7:2:1)	12.39 a	4.39	2.16 ab	1.42 ab	1.76	36.33
	BP + P + Z (6:2:2)	9.37 b	4.18	1.35 b	1.15 b	1.39	42.40
	F value	**6.778 ***	**1.940 ns**	**3.816 ***	**5.719 ***	**1.033 ns**	**1.106 ns**
4	BP + CTR + CP (6:2:2)	11.81	4.33	1.94 b	1.09 b	1.79	36.00
	BP + CTR + CP (5:2:3)	13.83	4.89	2.87 ab	1.64 a	1.78	36.50
	BP + CTR + CP + Z (5:2:2:1)	13.17	4.86	3.24 a	1.82 a	1.81	36.40
	F value	**2.189 ns**	**0.881 ns**	**5.141 ***	**10.763 ***	**0.005 ns**	**0.007 ns**
5	BP + CTR + FP (6:2:2)	11.54	4.44	2.31	1.54 a	1.51	39.97 a
	BP + CTR + FP (5:2:3)	12.31	4.58	2.44	1.64 a	1.49	40.27 a
	BP + CTR + FP + Z (5:2:2:1)	11.51	4.49	2.21	1.10 b	1.95	34.37 b
	F value	**0.140 ns**	**0.039 ns**	**0.120 ns**	**5.808 ***	**0.711 ns**	**8.718 ***
6	BP + CTR + P (6:2:2)	12.77 a	4.68	2.22	1.31	1.71	36.93
	BP + CTR + P (5:2:3)	10.50 b	4.34	2.11	1.45	1.45	41.10
	BP + CTR + P +Z (5:2:2:1)	10.62 b	4.45	1.79	1.30	1.56	39.20
	F value	**7.902 ***	**0.410 ns**	**0.505 ns**	**0.240 ns**	**2.167 ns**	**1.805 ns**

Evaluation of Municipal Solid Waste Compost as a Growing Media Component for Potted Plant Production

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Keywords: compost, substrates, growing media, municipal solid waste

Abstract

Increasing limitations to peat exploitation make it necessary to look for alternative organic materials as constituents of plant substrates. In this work, two municipal solid waste (MSW) composts were evaluated as growing media components for potted plant production, in comparison with *Sphagnum* peat (P) and composted pine bark (CPB). MSW composts showed higher electrical conductivity and pH values, as well as higher cation exchange capacity and nutrient supply potential than P and CPB. Physical properties of the substrates were generally within the recommended ranges for production of ornamental plants, although water capacity at -10 cm suction was slightly low. Substrates were prepared by combining the compost with P or CPB in different proportions (25, 50 and 75% by volume). Plant tolerance to the mixtures was evaluated by means of the cress (*Lepidium sativum* L.) germination test and the spring barley (*Hordeum vulgare* L.) growth test. Poor germination and growth were only observed in substrates with 75% compost, whereas substrates with 25% compost produced higher cress germination and better spring barley growth than P or CPB alone. The MSW composts evaluated can be used in the preparation of substrates, as partial substitutes for peat or composted pine bark, provided that they are not employed in proportions higher than 50%. Using MSW compost for substrate preparation would be economically attractive and would help to conserve finite peat resources.

INTRODUCTION

Soil-less substrates are used in horticulture as well as in the production of ornamental plants in pots. *Sphagnum* peat has been the most widely used growing media constituent, due to its high physical and chemical stability and low degradation rate. Nevertheless, the cost of high quality peat, together with the declining availability of this low-renewable resource, due to environmental pressures, has made it necessary to look for alternative materials. In Europe, efforts are being made to reduce the usage of peat in potting substrates and to increasingly use composts and recycled materials instead. Composts used in growing media should have a high degree of maturity, and adequate physical and chemical properties, such as particle size, porosity, water-holding capacity, air capacity, electrical conductivity and pH. Composting biodegradable MSW produces compost that is commonly used as a soil amendment. MSW compost has also been successfully used in the preparation of growing media (Ingelmo et al., 1998; Castillo et al., 2004). However several factors hinder the use of MSW compost as a constituent of growing media, namely the unpleasant odour, the variability in different batches, deficient quality control and high content of foreign matter. The raw materials as well as the composting process characteristics may influence MSW quality, and therefore the performance of each type of MSW compost should be tested.

The aim of the present work was to evaluate the use of compost made from aerobic and anaerobic transformation of the biodegradable fraction of MSW, in the preparation of substrates for plants in pots, as a peat and composted pine bark substitute, and to determine any limitation to its use.

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