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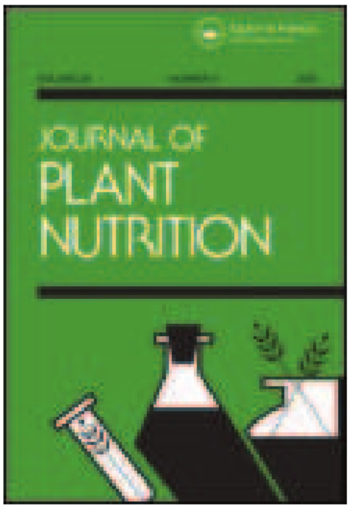

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EFFECT OF PEAT-REDUCED AND PEAT-FREE SUBSTRATES ON ROSEMARY GROWTH

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□ *The objective of this work was to study the use of four composts, obtained by agro-industrial, urban and green wastes, as growing media components on* Rosmarinus officinalis *L. Substrates were obtained by mixing each compost with peat in different proportions. Main physical and chemical characteristics of prepared substrates have been compared and, at the end of growing cycle, the biometric survey on main growing parameters and plant nutritional status was performed. The obtained results showed that substrates with 30% compost have main physical and chemical parameters comparable with those of the control. Best quality plants have been obtained substituting peat with 30% of compost, except with the olive mill compost. At the end, the green pruning compost can be recommended as growing media component (up to 50%) for the growth of* Rosmarinus officinalis *L., being able to determine high quality plants, together with an implemented plant nutrient efficiency.*

Keywords: compost, nutrient uptake, media, rosemary, pruning waste

INTRODUCTION

Soil-less substrates are generally used for growth of potted ornamental plants. The most common substrate is prepared with peat, due to its physical and chemical properties and stability. The prohibitive cost of peat, together with the depletion of a non-renewable resource such as peat (Benito et al., 2005) and environmental constraints, have favored the use of alternative materials as growing substrates (Urrestarazu et al., 2008).

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Organic residues as green wastes, urban solid or food processing industries wastes and animal excreta, after proper composting, can be used as growing media instead of peat with very good results (Chen et al., 1988, 2002; Garcia-Gomez et al., 2002; Grigatti et al., 2007a; Ribeiro et al., 2007). Various studies have been focused on the use of compost as a soil-less medium, replacing the peat for growing ornamental plants (Abad et al., 2001; Estévez-Schwarz et al., 2009; Ingelmo et al., 1998). Compost has been used even for vegetable germination seeds or transplanting, as an alternative to peat-based substrates, normally used for the production of vegetable seedlings (Herrera et al. 2009; Tittarelli et al., 2009). As an example, germination and growth of lettuce seedlings were not affected by the use of compost obtained from forestry wastes and solid phase of slurry, while the growth of tomato seedlings was highest in a substrate 100% compost (Ribeiro et al., 2007).

The production of compost offers not only an alternative substrate to peat, but reduces the volume of no-recycled wastes, decreasing environmental pollution as well. The European Union and Italian government strongly recommend recycling organic wastes in agriculture to reduce the amount of organic waste going to landfill sites by 20% in 2010 and 50% in 2050 (Council Directive 1999/31/CE; Italian law: Decreto Legislativo. n.22 05/02/1997).

Potted plants growth and quality depend on the characteristics of the used substrates. The roots development and physiology are strongly linked to the physical and chemical properties of growing media. Composts usually show a low porosity and water-holding capacity and a high bulk density, reducing porosity and air capacity (Benito et al., 2005; Ribeiro et al., 2007). The electrical conductivity is the main limiting factor to their use as substrates; their high salts concentration can negatively affect plant growth or quality, especially for species sensitive to salinity (Garcia-Gomez et al., 2002, Ribeiro et al., 2007). Several researches demonstrate that plant response to compost treatments is strictly related to the tested species (Garcia-Gomez et al., 2002; Grigatti et al., 2007b). At the same time, compost could have a positive effect on plant growth and resistance to stress; as a matter of fact, compost amendment may increase the disease suppressive properties of the potting mixture (Van der Gaag et al., 2007).

Origin and properties of organic wastes are very important for compost production; among the organic residues, green wastes are more interesting for the production of compost (Benito et al., 2005; Estévez-Schwarz et al. 2009). Large amounts of wastes, such as pruning waste, fallen leaves and grass cuttings, are generated during the maintenance of green spaces in urban zones. Currently use of land in private and public gardens of cities is rising, so even this type of compost from green residues is successfully used as plant growing media when mixed with perlite 50% by volume (Hartz et al., 1996) or with bark and sand (30:50:20 v/v) for tomato production (Spiers and Fietje, 2000).

Composted organic materials must be as homogeneous as possible (Lima et al., 2004), as an example, pruning wastes can have a seasonal variability and diversification, depending upon the predominant vegetation in the sampled area (Benito et al., 2006). It was demonstrated that the organic compost produced from organic residues previously selected presents a better result on corn plant development than the compost from non-selected ones (Lima et al., 2004). Mixing green wastes with industrial or urban products also produces a high quality compost. Quality control during compost production is absolutely necessary in order to obtain specific chemical and physical properties and an adequate degree of stability and maturity (Tittarelli et al., 2002).

Same investigations have been recently carried out on the nourishing potential of composts and theirs correlation with elemental content in plant organs, in order to verify the importance of the nutrient balance for plant growth; uptake and concentration of nutrient elements in plant tissues depend on many factors, such as the plant species and the temperature, salinity, pH and others physical and chemical proprieties of the substrates, as salts mix media (Garcia-Gomez et al., 2002). By applying vector analysis to the plant nutritional status, it is possible to relate experimental treatments with the nutrient supply. The simultaneous changes of nutrient concentrations in tissues and the biomass production show the extent to which different elements affect plant growth. This analysis is normally used to detect fertilizers' response and different plant stresses, as the competition for nutrients (Grigatti et al., 2007a, 2007b).

In this work, the selected specie was *Rosmarinus officinalis* L. cv 'Tuscan Blue', an evergreen shrub of the Mediterranean brushwood, that has a covering habit, with great ornamental interest, often used in parks and gardens and also in the planning of urban green areas with xeriscaping environment. The ornamental value is due to small, light blue flowers with intermittent blossom in the spring and summer and to plant resistance to warm and dry Mediterranean conditions in full sun areas.

This study was focused on the evaluation of four different composts used as components of substrates in substitution of peat for *Rosmarinus officinalis* L. growing. Moreover, the influence on the plant quality and nutritional status was investigated.

MATERIALS AND METHODS

Substrate Compositions

Four mature composts from different industrial and urban wastes locally available, produced by the composting plant "Eden '94" (Manduria, Toranto, Italy), were used as growing media components. The composts were obtained by composting different residual organic materials (mixed compost) or a single material (green compost):

C1: olive mill wastes,
C2: differentiated collection of organic wastes,
C3: green pruning compost,
C4: dairy industry wastes (50%) + green pruning wastes (50%).

The substrates were obtained by mixing increasing rates of each compost (30, 50, 70% v/v) with a fixed rate of inert material (30% v/v); the fulfilment to 100 of volume, if necessary, has been reached by adding *Sphagnum* peat to the mixture. A conventional compost-free substrate was also tested as control by mixing peat and the inert material (70:30 v/v). The inert material was constituted by 15% pumice, 10% kernel shells, and 5% podzolane, conventionally used as draining materials in the Apulia nurseries.

Plant Growing Conditions

The obtained thirteen substrates (four composts, each one added at 30, 50, 70% v/v to the inert material, and a control test, without compost addition) have been used for *Rosmarinus officinalis* L. growing. The research was conducted outdoor in containers in a private nursery, located in Monopoli (Bari), Southern Italy (40° 57′ 25,4″ N; 17° 17′ 25,7″ E; 9,14 m above sea level), with a Mediterranean warm and dry climate. Experiment started on 20 April and ended on 20 August 2006(temperature range: 18–29°C; relative humidity: 68–65%); local crop practices were adopted.

The plants were potted singularly in brown plastic containers of 2 L and 16 cm of diameter; growing density was 16 pots m^2. Fertigation was applied independently for each treatment, with a localized irrigation system. Plants were irrigated only with water for about one month after potting; later they were fed twice a day with a water-soluble nitrogen (N): phosphorus (P): potassium (K) fertilizer (5:1: 7.5) containing the main micronutrients. The electric conductivity level of fertigation was set up to 1.6 dS m^{-1}. The watering volume was 300 mL/pot/day, conventionally used in nursery for potted plant. Treatments were arranged in a randomized complete-block design with three replicates, each of them constituted by six plants (total plants: $13 \times 3 \times 6 = 234$).

Determination of Chemical and Physical Properties of Growing Media

Chemical and physical properties of growing media were analyzed before potting (D'Angelo et al., 1992). Regarding the growing substrates, the pH and the electric conductivity (EC) were determined according to the EN 13037 (1999) and EN 13038 (1999), respectively. The bulk density and the total porosity were determined according to Bibbiani and Pardossi (2004). The particles density was calculated according to EN 13041 (1999). The organic matter (OM) and the ash content were determined as reported in EN 13039 (1999) method. The water volume at pF1 (%) was determined according to EN 13041 (1999). The total nitrogen was determined by the Kjeldhal digestion (Bremner and Mulvaney, 1982). The macro- and microelements and the heavy metals content in the different substrates were determined by simultaneous plasma emission spectrophotometer (ICP-OES) on dry matter, incinerated at 400°C for 24 hours.

Plant Biometric Surveys and Elements Analysis

At the end of cultivation phase (after 120 days from transplanting), plant development has been monitored by biometric survey on the principal growing parameters: plant height and diameter, number of secondary stems, plant fresh and dry weight and percentage of dry matter.

In order to verify the statistical differences of the tested parameters in relation to the different substrates composition, results were evaluated by one-way analysis of variance (F test) at $P \leq 0.05$ and the means of treatments were compared by the Duncan test at the $P \leq 0.05$.

Nutrients and heavy metals content in the leaves were determined by simultaneous plasma emission spectrophotometer (ICP-OES) on dry matter, incinerated at 400°C for 24 hours.

Plant macro- and microelement contents were further evaluated by applying a vector analysis (Valentine and Allen, 1990; Scagel, 2003), which allows the simultaneous comparison of plant growth (i.e., dry weight) and nutrients content, through an integrated bi-dimensional graphic format (Haase and Rose, 1995; Swift and Brockley, 1994). For evaluating nutrient use efficiency, changes in biomass dry weight and elemental concentrations in plants, grown in the considered compost-based substrates, were plotted, normalizing them with respect to the same plant parameters obtained in the control peat-based substrate as percentage respect to control values. In the bidimensional plot, each value corresponds to a vector, originated from the point of intersection between the isolines (posed equal to 100% the values obtained for peat-based substrate treatment).

RESULTS AND DISCUSSION

Physical and Chemical Properties of Substrates

Main physical and chemical properties of substrates prepared at transplanting are reported in Table 1.

Bulk density, particle density, total porosity, pH, and EC of all compost based substrates differed significantly from the control peat-based substrate. The total porosity was always lower than the control substrate, as previously reported by other authors (Benito et al., 2005; Ribeiro et al., 2007). The pH

TABLE 1 Physical and chemical characteristics of growing media

Growing media	Bulk density (g cm^{-3})	OM (%)	Ash (%)	PD (g cm^{-3})	TP (% v/v)	WV pF 1 (%)	pH	EC (dS m^{-1})	N (%)	C/N
Control	0.36	62.1	37.8	2.49	83.2	27.6	5.9	0.08	0.33	94
C1-30	0.79	46.9	53.1	3.30	73.4	37.3	6.5	0.18	1.24	19
C1-50	0.85	51.2	48.8	3.03	72.6	54.8	6.5	0.24	0.78	33
C1-70	1.03	63.2	36.8	2.45	67.6	49.8	7.2	0.48	1.04	30
C2-30	0.79	29.7	70.3	5.22	75.5	62.6	7.0	1.10	0.71	21
C2-50	0.96	28.1	71.9	7.71	73.9	67.6	7.3	1.56	0.92	15
C2-70	1.25	27.0	73.0	5.74	66.5	65.2	7.8	2.62	1.05	13
C3-30	0.80	32.8	67.2	4.73	74.8	47.3	6.9	0.37	0.47	35
C3-50	0.96	22.0	78.0	7.04	74.8	51.7	7.1	0.52	0.62	18
C3-70	1.28	15.5	84.5	10.01	69.2	45.4	7.3	0.87	0.83	9
C4-30	0.90	35.4	64.6	4.38	75.2	57.7	6.5	0.38	0.52	34
C4-50	1.02	24.2	75.8	6.39	74.6	61.7	6.7	0.53	0.89	14
C4-70	1.27	23.9	76.1	6.48	74.3	63.5	7.1	0.79	1.34	9

Control = 70% peat; C-30 = 30% compost and 40% peat; C-50 = 50% compost and 20% peat; C-70 = 70% compost, for composts (C1-C4), 30% inert material is constant in each substrate (15% pomice + 10% kernel shells + 5% podzolane).

PD: particle density; TP: total porosity; WV: water volume; OM: organic matter; EC: electric conductivity.

increased as compost level increased in the growing media, with the highest values in the peat-free substrates (compost addition to 70%), reaching 7.8 in the 70% C2 growing medium.

Substrates with the highest percentages of compost showed the highest levels of EC; however, they remained under the acceptable limit when substituting peat up to 50%, with the exception of the C2 compost, which gave the highest EC values, probably due to the compost heterogeneous starting materials. The increased pH and EC in compost based substrates is well documented in literature. The pH and EC values far from the optimum range for an ideal substrate (Abad et al., 2001; Benito et al., 2006; Garcia-Gomez et al., 2002) can seriously compromise plant growth of acidophil and salt-sensitive species. High values of bulk density affect the root development and morphology when the substrate was more compact, the roots arranged in the upper part of the pot, in order to guarantee the development of the hypogean apparatus, together with the related adequate roots aeration.

Increasing compost percentages caused a decrement of OM, with the exception of mixtures with C1. The ash content, as expected, had an opposite trend. Total N was much higher in the mixtures than in the control, increasing proportionally with the compost percentages. The C/N ratio was lowered in compost-based substrates; only the olive mill compost (C1) was characterized by an opposite trend. This was probably due to an incomplete mineralization of the labile fraction of C1 organic matter (Benito et al., 2005).

The control was less rich in nutrients than the compost-based substrates, with some differences due to the composting materials. Macro- and

TABLE 2 Total macro- and micronutrients and heavy metal contents (mg $kg^{-1}{}_{d.m.}$) (d.m. = dry matter) in growing media at transplant. For abbreviations, see Table 1

	mg $kg^{-1}{}_{d.m.}$													
Growing media	P	K	Ca	Mg	Na	Fe	Mn	Cu	Zn	B	Ni	Pb	Cr	Cd
Control	1561	1027	5927	660	732	239	69	13	12	12	2.88	12.0	0.86	0.06
C1-30	2982	5645	14100	1736	1128	974	88	17	65	14	1.96	17.2	2.13	0.18
C1-50	2273	4960	12615	832	1015	895	81	15	41	13	1.92	15.0	2.25	1.26
C1-70	2288	7155	12910	585	1157	1006	78	16	38	15	2.05	15.5	2.66	1.42
C2-30	3565	8097	19885	2617	2177	1405	134	28	111	29	2.36	23.4	4.57	0.04
C2-50	4680	10410	21683	4953	2645	1771	163	43	156	42	3.62	28.7	5.78	0.74
C2-70	6170	12932	23190	5375	3605	2234	204	59	228	55	4.25	35.5	7.96	1.72
C3-30	3520	3512	21347	4662	1224	1305	153	24	101	22	2.83	52.5	4.24	0.26
C3-50	3012	3132	21895	4102	766	1147	151	19	78	17	2.89	38.7	4.50	0.66
C3-70	3050	3285	22955	4732	643	1231	167	20	86	18	2.89	41.9	5.65	0.32
C4-30	3327	3492	18385	3075	1155	894	121	11	51	11	1.39	20.8	2.77	0.14
C4-50	4912	5040	20357	4022	1230	1229	133	13	92	17	1.52	22.1	4.27	0.25
C4-70	6580	4505	21457	4457	1183	1430	134	16	133	22	2.05	24.0	5.82	0.11

micronutrients contents in the substrates generally increased when the compost rate raise in the mixture (Table 2).

The heavy metal total contents (Table 2) for all the substrates were lower than the values imposed by national and European law (Italian law: Decreto Legislativo n.75 29/04/2010), with the exception of the Cd content in 70% C2 mixture, probably due to the presence of differentially collected organic wastes. This confirmed the general good quality of the considered composts, the concentration of heavy metals depending on the quality of raw starting materials as well as the applied composting process (Smith, 1992).

Plant Growth and Quality

After four months, the heights of rosemary plants were similar for the substrates with compost substitution up to 50%, ranging from 17 cm in C2–30% to 27 cm in C4–30%, this was similar to the control. A slight decrease was detected when all the composts were added at 70% (Table 3).

Regarding the diameter (D) and stem numbers, similar results by the control were obtained with compost substitution up to 50% for D and up to 30% for stems number (Table 3); on the other hand, the complete replacement of peat with compost induced a diameter reduction of about 24%. These results are interesting because plant ornamental quality is closely related to these characters; in the investigated specie, the *Rosmarinus officinalis* L. cv 'Tuscan Blue', the diameter and stem numbers were, among quality parameters, the most important ones. In fact, this species is often used as a ground cover plant in gardens and public parks.

TABLE 3 Biometrical parameters of plants at the end of growing cycle

Growing media	Plant height (cm)	Plant diameter (cm)	Secondary stems (n)	Plant fresh weight (g)	Plant dry weight (g)	Plant dry matter (%)
Control	29.3a	51.3abc	33.7a	173.6ab	41.0abc	23.7d
C1-30	21.6bcd	45.8cde	25.7bc	83.6de	25.2d	30.2bc
C1-50	18.8cd	42.7cde	20.3cd	78.2e	24.6d	32.0abc
C1-70	18.8cd	40.4e	16.3d	92.0cde	28.9cd	31.4bc
C2-30	17.0cd	50.1abc	21.3cd	127.7cd	43.8ab	34.4a
C2-50	20.3bcd	41.2de	17.3d	93.5cde	27.5cd	29.4c
C2-70	14.7d	43.3cde	21.0cd	97.4cde	28.8cd	29.5c
C3-30	23.4abc	54.9a	25.3bc	171.9ab	50.6a	29.4c
C3-50	19.7bcd	48.9bcd	18.0d	133.1bc	43.6ab	32.6ab
C3-70	20.2bcd	44.9cde	25.3bc	111.3cde	32.8bcd	29.3c
C4-30	26.9ab	54.0ab	29.0ab	178.4a	46.8a	26.1d
C4-50	24.1abc	47.1bcd	21.0cd	90.2cde	27.1cd	30.3bc
C4-70	18.7cd	45.7cde	23.0bcd	96.5cde	29.7cd	30.5bc

Means with different letters, in the same column, indicate significant differences ($P \leq 0.05$) using Duncan test.

The plant yield, expressed as fresh weight of the aerial part, was very close to that of the control for C3 and C4 up to 30% of compost addition. A similar trend was detected on dry weight basis. Rosemary grown in peat-free media had a significant lower fresh weight (a reduction of about 40%), with respect to 30% and 50% substitutions, confirming a depressive effect played by the highest amount of composts on plant development (Table 3).

For all of the studied substrates, the percentage of plant dry matter was higher than the control (Table 3), indicating lower water contents in plants grown on compost-based substrates.

When a strong reduction in development was detected, the plants were unmarketable, but no phytotoxic effects neither deficiency symptoms were observed, so they were re-potted in a nursery.

These results agree with those obtained by others authors, which reported good growth and development of plants in compost-based substrates; therefore, it is proposed that compost could be a partial replacement of peat (Abad et al., 2001; Benito et al., 2005; Chen et al., 1988; Ingelmo et al., 1998; Lima et al., 2004). These positive results obtained with 50% C3 substrate are justified by the use of pruning residues as compost starting materials, which are very similar, after stabilization by composting, to the humic matter present in peat (Trinchera et al., 2007).

The compost obtained from olive mill wastes (C1) wasn't suitable as a growing media component in soilless cultivation of Rosemary, independently from its concentration. These results partially confirm a previous work, where the green compost (C3) was efficient for aloe plant development, independently from the rate, but the growth was reduced when compost from olive mill waste (C1) was applied at the highest doses (Rea et al., 2009). This questionable performance of C1 compost was due to a phytotoxic effect played by some organic compounds of polyphenolic origins, often present at large extent in this typology of compost (Calabretta et al., 2004). Different responses may also depend on the tested species, as reported by Grigatti et al. (2007b).

Plant Nutritional Status

The elemental concentrations in plant tissue grown in the control peat substrate are reported in Table 4.

These values, together with the plant dry weight, were taken as reference standard values, posing equal to 100% in Figure 1.

The related concentrations of macro- and micro-elements in plant tissues grown in based-compost substrates are expressed in % with respect to the values of the control, and they have been compared using vector analysis method in an integrated graphical representation (Figure 1). The isoline contents represent combinations of dry weight and each elemental concentration, giving constant content per unit dry weight.

Bi-dimensional graphical representation allowed to describe results on the basis of each vector shift: a decrease of one element concentration respect to the control (vector space below the horizontal isoline), with a contemporary increase of plant dry weight (vector space on the right side of vertical isoline) means an increase of plant nutrient use efficiency; on the opposite, a decrease of elements concentration respect to the control, associated to a decrease of plant dry weight (vector space on the left side of vertical isoline) indicates a nutrient deficiency. When nutrient concentrations increased (vector space over the horizontal isoline) and plant dry weight decrease respect to the control, a phytotoxicity effect was evident.

Plant tissue composition was significantly affected by the different treatments, depending on the compost type and rate.

Dry weight of plants, grown in the substrates with 30% C2, C3 and C4 and 50% C3 was higher than the control. Consequently, the corresponding concentration of each nutrient was placed in the right side of each graph. All the other vector shifts for the considered substrates (C1 from 30% to 70%, C2 and C4 from 50% to 70% and C3 at 70%) are represented on the

TABLE 4 Elemental concentration in plant tissues, grown in the control peat substrate

Macroelement	mg kg^{-1} d.m.	Microelement	mg kg^{-1} d.m.
P	2530	Fe	64.5
K	22234	Mn	109.4
Ca	13569	B	25.2
Mg	4675	Cu	7.9

d.m. = dry matter. The average values are reported.

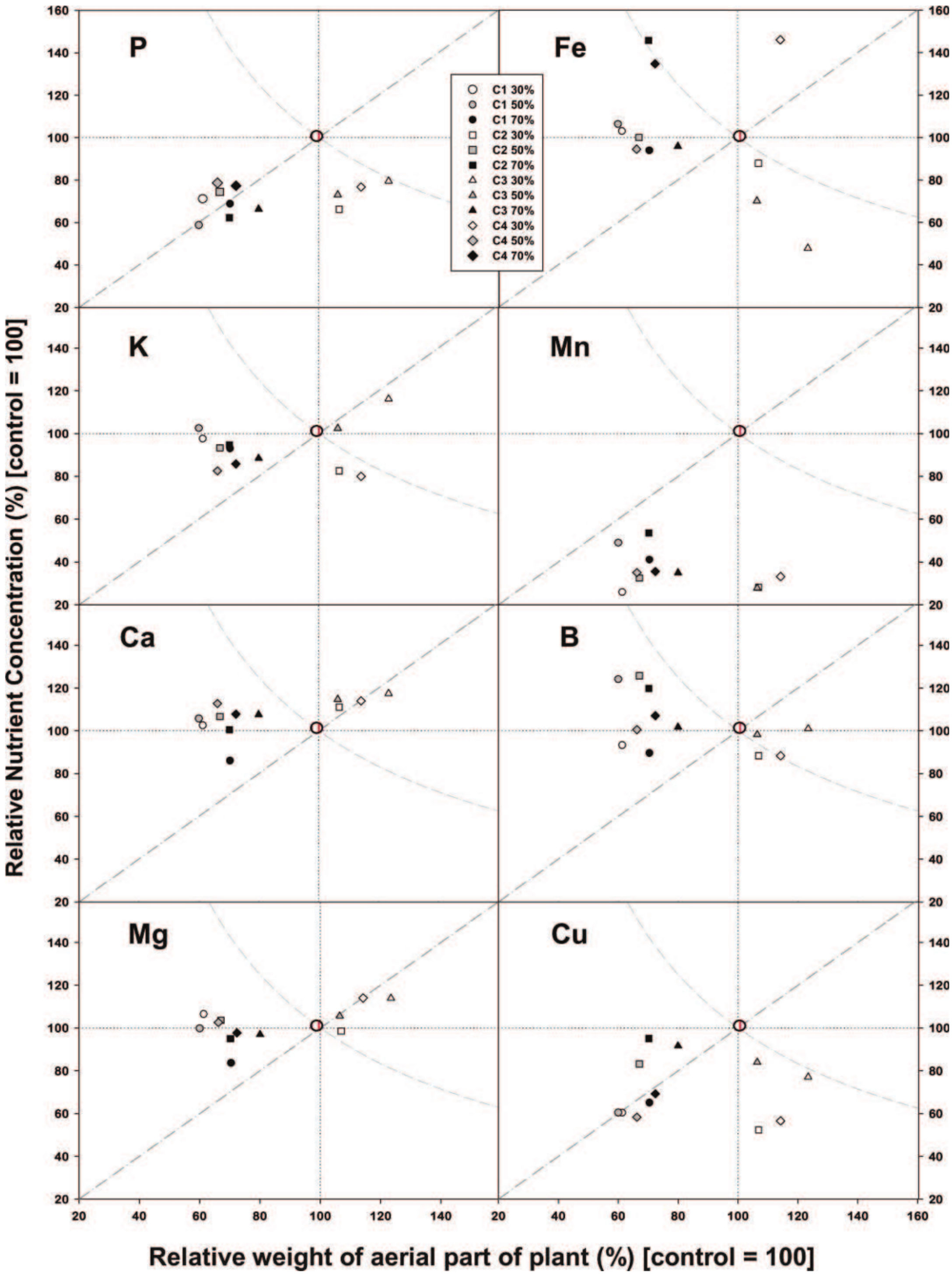

FIGURE 1 Comparison of macro- and micronutrients concentration and dry weight of aerial part of plant at the end of growing cycle. Control values of dry weight and concentration used as reference (point of isolines intersection). (Color figure available online.)

left of the control line (100% dry weight), due to the fact that they produced plants with a dry weight lower than that of the control plants (Figure 1).

In all treatments, among the macronutrients, P concentration was lower than in control, but in the substrates with C2 and C4 up to 30% rate and C3 up to 50% it was correlated to the increase of dry weight, showing a more efficient use of phosphorus. In the others treatments, P concentration was located in the "deficiency" vector space (Figure 1).

The K concentration was lower while the calcium (Ca) concentration was higher in all the compost mixtures compared to the control, with the exception of C1 70%. The Ca concentration was abundant in the substrates, which caused a plant growth reduction; on the other hand, K concentration was generally deficient. Moreover, both the Ca and magnesium (Mg) uptake and availability were positively related to plant growth in substrates C2, C3, and C4 in 30% rate and C3 50% (Figure 1), while K uptake was improved only in C3 30% substrate and in the 50% one; in C2 and C4 at 30% rate, efficiency use of K nutrient was increased. In the other treatments, K concentration was shifted to the "deficiency" vector space. The C1 70% substrate was the most deficient in Ca and Mg.

In all compared substrates, the copper (Cu) and manganese (Mn) concentrations were lower (between −10% and −40% for Cu and −50% for Mn, respectively) than the control. These concentrations were shifted from the vector space representing higher nutrient use efficiency to the vector space, representing treatments with nutrient limiting factor, corresponding to a lower plant growth (Figure 1).

The iron (Fe) concentration was generally lower in all the treatments respect to the control, with the exception of C4 30%, which gave the highest Fe concentration together with an increase in plant dry weight. The C2 70% and C4 70% gave an increase of Fe plant uptake, even if a decrease in plant weight was registered.

Boron (B) was generally not limiting and comparable to that of the control, but in C2 and C4 30% was lower, following a dilution by growth, while it became concentrated in the substrates with the highest rate of compost (Figure 1).

As far as the heavy metals are concerned, they were not accumulated in the aerial part of plant, confirming the good quality of the used composts (data not shown).

No increased uptake of plant nutrients were detected in all the tested substrate in relation to comparable plants growth, so no luxury consumption was observed.

Obtained results indicated that firstly, there is a limit in peat substitution and, secondary, that this limit is strictly connected to the compost used for substitution. The findings related to C1, based on olive mill wastes, attested that some raw starting material are not suitable to be composted for the preparation of substrates, inducing a general decrement in rosemary biomass production for all the percentage of substitution (30%, 50% and 70%). On the contrary, C3 compost, based on green residues, or C4 one, based on green residues and dairy industrial wastes, seem to be very efficacious in increasing biomass yield, with a contemporary reduction of nutrient uptake, so constituting optimal growing media for rosemary plant. It should be remarked that the excessive increase of compost percentages in substrates is supposed to induce a deficiency of P, K, Mn, and Cu availability, while the contemporary increase of Ca and B concentrations limited the plant growth for their excessive accumulation in vegetal tissues, which could determine a potentially phytotoxic effect.

Differences in nutrient availability for plants growing in the different substrates are a result of overall physic-chemical properties, due to the type of compost and rate of peat substitution, as reported by Scagel (2003). These properties directly influence root development and, as a consequence, nutrients use efficiency. For instance, in our study, although initially the total nutrients content of compost-amended media was generally higher than the control, during the growing cycle till the end, the available macro and micronutrients were selectively replaced by nutrient solution. This indicated that the adsorbent capacity of roots is more determinant than the mere nutrients content in the substrates that evidently may influence the nutrient uptake just the first period after potting.

CONCLUSIONS

Despite the increase of pH and EC values, the used compost gave substrates able to produce plants without incurring phytotoxicity. The plants grown on compost based substrates, except the olive mill compost, showed better or comparable biomass production and ornamental quality with respect to those obtained in control peat-substrate. It can be concluded that, in particular, the green pruning compost can be recommended as growing media component (up to 50%) for the growth of *Rosmarinus officinalis* L, able to determine high quality plants together with an implemented plant nutrient efficiency.

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