EARTHWORM HUMUS FOR THE GROWTH OF VEGETABLE PLANTS

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ABSTRACT

In the 20th century, the arrival of intensive agriculture brought about the phenomenon of soil impoverishment. Chemical fertilization methods, the study of applied genetics, the mechanization of agriculture and the development of phytosanitary techniques have increased agricultural production. Earthworm humus constitutes an authentic biological fertilizer in terms of organic material and microbial population. The trials performed at CREA-OF, Pescia (PT), showed the ability of earthworm humus to increase the quality of basil plants, strawberry and sage, in terms of vegetative and root biomass.

Keywords: alternative substrates, vegetables, plant quality, soil improver, plant stimulation

INTRODUCTION

Since the beginning of the 1990s, numerous environmental associations have been pressing in the horticultural nursery field to reduce the use of peat as a substrate for plant growth, sustaining that the natural environments from which peat is extracted are destroyed by this process (Neal, 1991). As a consequence of this attitude, greenhouse cropsshaved ways been in search of alternative substrates, characterized for example by mixtures containing peat, pine bark, coir, peat, vermiculite, in various percentages.

New components in the substrate can offer better growing conditions for plants and at the same time reduce plant production costs compared to peat (Stamps and Evans, 1999). A large part of the research focused on the study of materials such as solid urban waste or agricultural production residues. At the same time, however, these materials may have disadvantages such as the variability of composition, limited availability and the presence of waste such as glass, metal, lead and mercury, which make them difficult to process (Konduru and Evans, 1999). Among the organic materials animal manure has been used on agricultural land for centuries, because it is considered a good supplier of available phosphorus (Wen et al., 1997).

In the organic waste sector, earthworms have always shown greater preference for animal waste (Laird and Kroger, 1981). Earth worm production can be both profitable and reduce the environmental impact of animal waste (Edwards and Fletcher, 1988). Earthworm compost has a great potential especially used for the formulation of potted substrates (Buchanan et al., 1988). Tomar et al. (1998) have grown carrot plants (Daucus carota L.) in pots containing field arth or mixed with vermin compost, achieving higher yields in substrates where vermin compost was present. Kalembasa et al. (1998) evaluated the effect of different sources of N (manure, ammonium nitrate and earthworm humus) and obtained higher yields on Raphanus sativus L. and Capsicum annum L. with earthworm. Earthworms influence the structure of the compost by forming macropores, which allow oxygen to enter, and also increase the stability of the humus and its ability to retain water (Lavelle, 1988; Willems et al. 1996). On the occasion of the passage through the worms, not only the macrominerals but also the mineral components that serve as food are subject to the following digestive enzymes and a grinding process (Das et al., 2007, Sharif and Jan, 2008). A improved grass grow th around worm waste in dicas in creased availability of plant nutrients, with perhaps nitrogen being the mineral that is subject to the great influence (Buckman and Brady, 1976). With in its digestive tract, soil material under goes transformations, with de composition of organic matter and avail ability of nutrients for plants (Balota et al., 1998).

In this context, CREA-OF (PT), following collaboration with the Centre of Tuscan earthworming (CLT), (Orzignano, San Giuliano, PI), has experimented with mixtures of peat and...

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earthworm humus (in different percentages) to evaluate the effectiveness of compost in the production of horticultural plants (Basil, Strawberry, and Sage), as a fertilizer (if used at lower percentages) or as a real growth substrate when it replaces 100% peat.

**MATERIAL AND METHODS**

**Greenhouse Experiment and Growing Conditions**

The experiments were carried out in early June 2015, were carried out in price experimental greenhouses of CREA-OF of Pescia (PT), Tuscany, Italy (43°54′N 10°41′E), on plants of basil (Fig.1), strawberry (Fig.2) and sage. The plants for 3 vegetable species were placed in pots with a diameter of 16, 20 plants for thesis, divided into 4 replicas of 5 plants each. The experimental theses of the test were:

- **Control (CTRL):** Peat 100% + fertilization (5 kg m−3 of Osmocote Pro®) 3 - 4 months containing 190 g kg−1 N, 39 g kg−1 P, 83 g kg−1 K;
- Humus 10% (HUM10): Peat 90% + Humus 10% + fertilization (5 kg m−3 of Osmocote Pro®);
- Humus 20% (HUM20): Peat 80% + Humus 20% + fertilization (5 kg m−3 of Osmocote Pro®);
- Humus 50% (HUM50): Peat 50% + Humus 50% + fertilization (5 kg m−3 of Osmocote Pro®);
- Humus 80% (HUM80): Peat 20% + Humus 80% + fertilization (5 kg m−3 of Osmocote Pro®);
- Humus 100% (HUM100): Humus 100% + fertilization (5 kg m−3 of Osmocote Pro®).

The substrates used were a universal Brill® soil with a pH of 6 and earthworm humus provided by the Centre of Tuscan earthworming (CLT), (Orzignano-San Giuliano Terme (PI)), having the following analysis (organic nitrogen (N) 1.9%; total nitrogen (N) 2%; phosphorus (P2O5) 0.5%; potassium (K2O) 0.8%; organic carbon 24.5%; ratio C/N 12.2%; pH 7.5; organic substance 49%; extractable organic substance (% on organic substance) 52.5%. Irrigation water was supplied through the drip irrigation system (2 drippers per pot with a total flow rate of 7.5 L h−1, on average) using a triggering irrigation timer set to four times per day. The measurements carried out at the end of the experimentation on the plants were: plant height, vegetative fresh weight, roots fresh weight, inflorescences fresh weight, beginning of flowering (basil), productivity (considered in terms of fresh weight of the fruits in a cultivation cycle of 3 months (strawberry).

**Statistics**

The experiment was carried out in a randomized complete block design. Collected data were analysed by one-way ANOVA, using GLM univariate procedure, to assess significant (P ≤ 0.05, 0.01 and 0.001) differences among treatments. Mean values were then separated by LSD multiple-range test (P = 0.05). Statistics and graphics were supported by the programs Costat (version 6.451) and Excel (Office 2010).

**RESULTS**

Humus treatments significantly increase dall the biometric parameters of the plants analysed. In particular, on basil (Tab.1) the insertion of higher percentages of humus in the substrate determined, compared to the control in peat, a significant proportional increase in the height of the plants, in the vegetative fresh weight, in the root fresh weight and in florescences fresh weight. There is also an early flowering rate in the basil plants grown in the substrate where the percentages of substitution of peat with humus were higher. Also in strawberry (Tab. 2) there is a significant tin crease in vegetative fresh weight and root fresh weight a higher humus concentrations in the substrate. There is also an increase in the production of strawberries, over a predetermined period of 3 months, in all the theses in which the humus has replaced the mixture of peat. In particular the theses with 80% humus, 90% humus and 100% humus seem to be the most performing in fruit production compared to 100% peat control. In (Tab. 3) on sage, all treatments in which earthworm humus was present resulted in a significant increase in vegetative fresh weight and root fresh weight, passing 38.30 g and 16.63 g in 100% humus respectively, compared to 32.20 g and 12.47 g in the peat control.

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Plant height (cm)</th>
<th>Vegetative fresh weight (g)</th>
<th>Root fresh weight (g)</th>
<th>Inflorescences fresh weight (g)</th>
<th>Start of flowering (date)</th>
</tr>
</thead>
<tbody>
<tr>
<td>CTRL</td>
<td>7.29 a</td>
<td>35.72 e</td>
<td>22.47 f</td>
<td>8.07 e</td>
<td>July 9th</td>
</tr>
<tr>
<td>HUM10</td>
<td>7.46 d</td>
<td>36.43 e</td>
<td>25.27 e</td>
<td>8.13 e</td>
<td>July 26th</td>
</tr>
<tr>
<td>HUM20</td>
<td>7.83 c</td>
<td>38.27 d</td>
<td>28.33 d</td>
<td>9.57 d</td>
<td>July 25th</td>
</tr>
<tr>
<td>HUM50</td>
<td>8.22 b</td>
<td>43.30 c</td>
<td>29.97 c</td>
<td>10.40 c</td>
<td>July 23th</td>
</tr>
<tr>
<td>HUM80</td>
<td>8.74 a</td>
<td>44.67 bc</td>
<td>32.33 b</td>
<td>11.17 b</td>
<td>July 26th</td>
</tr>
<tr>
<td>HUM90</td>
<td>8.89 a</td>
<td>45.57 b</td>
<td>33.67 ab</td>
<td>12.23 a</td>
<td>July 19th</td>
</tr>
<tr>
<td>HUM100</td>
<td>8.90 a</td>
<td>47.47 a</td>
<td>34.33 a</td>
<td>12.57 a</td>
<td>July 19th</td>
</tr>
</tbody>
</table>

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Each value reported in the graph is the mean of three replicates ± standard deviation. Statistical analysis performed through one-way ANOVA. Different letters for the same parameter indicate significant differences according to LSD test (P = 0.05).

Table 3 Effect of earthworm humus on Sage plants

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Vegetative fresh weight (g)</th>
<th>Root fresh weight (g)</th>
</tr>
</thead>
<tbody>
<tr>
<td>CTRL</td>
<td>32.20 f</td>
<td>12.47 g</td>
</tr>
<tr>
<td>HUM10</td>
<td>33.47 e</td>
<td>12.87 f</td>
</tr>
<tr>
<td>HUM20</td>
<td>34.63 d</td>
<td>14.23 e</td>
</tr>
<tr>
<td>HUM30</td>
<td>35.90 c</td>
<td>14.93 d</td>
</tr>
<tr>
<td>HUM50</td>
<td>37.17 b</td>
<td>15.47 e</td>
</tr>
<tr>
<td>HUM80</td>
<td>37.73 ab</td>
<td>16.23 b</td>
</tr>
<tr>
<td>HUM100</td>
<td>38.30 a</td>
<td>16.63 a</td>
</tr>
</tbody>
</table>

Each value reported in the graph is the mean of three replicates ± standard deviation. Statistical analysis is performed through one-way ANOVA. Different letters for the same parameter indicate significant differences according to LSD test (P = 0.05).

**CONCLUSION**

These trials showed several benefits that can be obtained through the use of earthworm humus: improvement quality of basil, strawberry and sage plants in terms of vegetative and radical biomass and to influence their productivity, better use of fertilizers and water. The test also showed that earthworm humus can be a good organic fertilizer, which can ensure a reduction of synthetic fertilizers, while a higher percentages (90%-100%) can be considered a real substrate of cultivation, able to replace the peat in part or totally.

**References**


**DISCUSSION**

The experiments have shown the ability of earthworm humus, when placed in a growing medium, to significantly increase the quality of basil, strawberry and sage plants in terms of vegetative and radical biomass and to influence their productivity (especially in strawberry). This improvement could be due in particular to the rich presence of microbial flora that is found in earthworm humus, which can modify the structure of the substrate, in particular by increasing the presence of oxygen, stabilizing the material and increasing the capacity to retain water (Lavelle, 1988; Willems et al. 1996; Núñez, 2000; Álvarez-Solis et al., 2010). These microorganisms are very ofenable to solubilize the nutrients already present in the substrate or to create symbiosis with the root systems of plants, increasing the absorption capacity of nutrients (Schüssler et al., 2001). The earthworm humus, also on the basis of the results of this test, can there fore certainly be considered a valid substitute for organic materials included in growth substrates used in horticulture. It can certainly lead to an improvement in plant quality and a significantreduction in the use of water. At lower percentages (10%-20% mixture) earth worm humus can be a good organic fertilizer, which can ensure a reduction of synthetic fertilizers, while a higher percentages (90%-100%) can be considered a real substrate of cultivation, able to replace the peat in part or totally.


