Seed germination and seedling growth of tomato as affected by different types of compost water extracts

Doncean Ancuța1*, Şumălan Renata1, Beinșan Carmen1, Şumălan R.1

1Banat University of Agricultural Sciences and Veterinary Medicine Timișoara, 119 Calea Aradului, 300645 Timișoara, Romania

Corresponding author: E-mail: donceanancuta@yahoo.com

Abstract

We investigated the effects of water extracts of composts (CWE) from six different types of composts (different compositions of organic matter), using seed germination bioassay as an indicator of phytotoxicity in compost extracts.

After incubation was determinate number of seeds germinated in each type of CWE at 24, 48 and 72 hours, evaluating the compost maturity. Germinated seeds were counted (nVSS and nVSC) and root growth (RLS and RLC) measured. After 14th day was measured the Germination index (GI) according formula GI = nVSS x RLS / nVSC x RLC x 100, where nVSS and nVSC express the number of viable seeds in the sample and in the control, respectively (extract compost was replaced by distilled water); RLS and RLC expressed the root length in the sample and in the control, respectively. (if the compost is providing plant nutrients adequately).

Key words

seeds germination, compost extracts, tomato seeds, phytotoxicity

Numerous studies have demonstrated the potential of composted organic matter not only as substitutes as a growth substrate but also to stimulate plant growth and suppress soil-borne diseases (3). The level of stability and maturity of composts is an essential aspect of compost quality. (1) Maturity is related to the effect of composts to crops and indicates the presence or absence of phytotoxins (4).

Immature compost may contain phytotoxins that will often kill seed embryos. Seeds grown in immature compost won't sprout or may die immediately after sprouting. Seed germination and plant growth bioassay are the most common techniques used to evaluate compost phytotoxicity (5) (quality).

Composting has been defined as a biological process through which microorganisms convert organic materials into useful end products, which may be used as soil conditioners and/or organic fertilizers (2). The solid particulate products of composting, which are extracted during the maturation and curing phase are referred to as compost (6; 7).

Compost extracts are filtered products of compost mixed with any solvent, usually water, but not fermented or brewed (10).

A widely used maturity index is the germination index (GI); it is based on relatively simple to perform seed phytotoxicity tests, which are germination bioassays that quantify seed growth upon the application of compost liquid extracts to the seeds. The GI was first introduced by Zucconi et al. (1981) (11). According to Zucconi et al. (1981), GIs allow to evaluate both low levels of toxicity, that affect root growth, as well as high levels of toxicity, which affect seed germination. Based on that, it would be reasonable to state that GIs lower than 100% indicate a potential phytotoxicity, whilst values greater than 100% indicate a beneficial effect on seed growth, and therefore indicate a mature compost (4).

Materials and Methods

In this study were analysed six samples of different types of compost: C1, C2, C3, C4, C5, C6 (made from different mixtures of manure), a control sample (distilled water) and tomato (Lycopersicum esculentum L.) seeds, from the variety Aurora 100.

All these studied composts were obtained from different organic matter compositions. We made 3 composting recipes which were composted in the same time in plastic bags and boxes. C1, C2 and C3 were composted in plastic bags and C4, C5, C6 were composted in boxes.
Table 1

<table>
<thead>
<tr>
<th>Compost</th>
<th>Organic matter</th>
<th>C/N</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>RECIPE N°1</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>C1, C4</td>
<td>Wheat straw dry</td>
<td>80</td>
</tr>
<tr>
<td></td>
<td>Chicken manure</td>
<td>10</td>
</tr>
<tr>
<td></td>
<td>Grass lawn</td>
<td>20</td>
</tr>
<tr>
<td><strong>RECIPE N°2</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>C2, C5</td>
<td>Sawdust</td>
<td>300</td>
</tr>
<tr>
<td></td>
<td>Straw</td>
<td>80</td>
</tr>
<tr>
<td></td>
<td>Chicken manure</td>
<td>10</td>
</tr>
<tr>
<td><strong>RECIPE N°3</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>C3, C6</td>
<td>Green leaves</td>
<td>60</td>
</tr>
<tr>
<td></td>
<td>Fresh chicken manure</td>
<td>10</td>
</tr>
<tr>
<td></td>
<td>Caw manure</td>
<td>20</td>
</tr>
</tbody>
</table>

For the compost extract process, 100 ml of distilled water were mixed with 50 g media from six variants of the compost in Erlenmeyer flasks. The compost – water mixture was shaken for one hour at room temperature.

For the germination assay we used Petri dishes (10 cm diameter), Wathmann filter papers, tomato seeds 30/dish, 6 ml of compost extracts and transparent plastic foil.

All the simples (C1r1...C1r3,......, C6r1...C6r3) we incubate it in a Germinator (TEMI 850 WISE CUBE) at 27°C at dark.

Fig. 2 Petri dishes with tomato seeds placed in the dark for germination in a Germinator (TEMI 850 WISE CUBE).
In the 14th day we measured seeds root growth, to determinate the vigorousness of tomato plants and the quality of each type of compost.

Results and Discussions

After 24, 48 and 72 hours was counted the germination seeds and we noticed that the germination average on all compost extracts is over to control.

Table 2

<table>
<thead>
<tr>
<th></th>
<th>C</th>
<th>C1</th>
<th>C2</th>
<th>C3</th>
<th>C4</th>
<th>C5</th>
<th>C6</th>
</tr>
</thead>
<tbody>
<tr>
<td>24 hours</td>
<td>4 of 30</td>
<td>8 of 30</td>
<td>6 of 30</td>
<td>4 of 30</td>
<td>7 of 30</td>
<td>8 of 30</td>
<td>7 of 30</td>
</tr>
<tr>
<td>48 hours</td>
<td>12 of 30</td>
<td>24 of 30</td>
<td>20 of 30</td>
<td>14 of 30</td>
<td>23 of 30</td>
<td>22 of 30</td>
<td>17 of 30</td>
</tr>
<tr>
<td>72 hours</td>
<td>15 of 30</td>
<td>26 of 30</td>
<td>25 of 30</td>
<td>22 of 30</td>
<td>23 of 30</td>
<td>26 of 30</td>
<td>25 of 30</td>
</tr>
<tr>
<td>Average %</td>
<td>50%</td>
<td>86,66%</td>
<td>83,33%</td>
<td>73,33%</td>
<td>76,66%</td>
<td>86,66%</td>
<td>83,33%</td>
</tr>
</tbody>
</table>

In Table 2 C1 and C5 showed a equal and the highest germination average of 86,66% in comparison with C2 and C6 which was the second high germination average under 80%, the same equal. Insteed as can be seen C3 have the lowest germination in coparation with the other compost extracts, but more highest than control sample. Our results are in accordance with other studies that have shown beneficial effects of aqueous extracts of compost on seed germination (8; 9).

After incubation at 27°C for 14th days in the dark, germinated seeds were counted and the root length was measured.

Fig. 3 Roots measurements comparation between control and each type of compost extracts

Analysis results regarding figure 3 reveals the differance between seeds root growth and their scattered. All the seeds roots from compost extracts are longer in coparation with control. Was observed that some of the seeds had scattered roots like at C3, C4, C5, C6, which mean that this small plants will become
vigorous plants in the future, due to compost which is providing necessary plant nutrients. A statistic of seeds root growth was made, to observe the variation between compost extracts and control.

![Fig. 4 The roots length in compost extracts and control](image)

The results from this figure reveals a variation of root length in all the compost extracts and control too. The highest standard deviation we noticed at C4 and C3 (compost extracts), more than control. C5 have the shortest standard deviation then other compost extracts which mean that have all the nutrients necessary for growth and development of tomato plants (*Lycopersicum esculentum* L.).

The germination index (GI) was calculated according this formula:

$$GI = \frac{nVSS \times RLS}{nVSC} \times \frac{RLC}{RLC} \times 100$$

where $nVSS$ and $nVSC$ express the number of viable seeds in the sample and in the control, respectively (extract compost was replaced by distilled water); $RLS$ and $RLC$ expressed the root length in the sample and in the control, respectively (11).
Analysis results regarding figure 5 reveals that all the CWE have the germination index over 100% which mean that all composts are mature, don’t have any potential of phytotoxicity.

Was showed that C5 compost extract had the highest germination index from all the CWE, and the lowest one was C4.

According other studies on the bioassay tests (5:11) our results showed the same differences between control were the GI was lower and the compost extracts were the GI was highest.

Conclusions

According this study was observed the differences between six type of compost extracts, that the composition of each compost have effects on tomato seeds.

It is found that the phytotoxicity of the studied composts don’t exist, but was find that the quality is not the same.

Was observed that the composted methods make the difference between germination rate and the roots length too, even they have the same organic matter composition. From this difference has been established, that some of this recipes should be composted just in plastic bags for example: compost C1, others just in boxes like compost: C6 and others like composts: C5 and C2 in boxes and plastic bags.

The highest quality of this six compost extracts had C5 compost extract followed by C6 compost extract.

The lowest quality had C4 compost extract.

According the GI values highest than 100% indicate a beneficial effect on seed growth, and indicate a mature compost.

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