Influence of the composting process on nematodes in the soil substrate

ABSTRACT
The application of compost is a beneficial and economical solution for improving physical and biochemical properties of soil. Many of the farmers issues relate to the different organisms involved in the composting process and the effects of compost on the soil fauna. Determining the species composition of nematodes before using compost is an assessment of the ongoing process of composting and essential for agricultural production. The aim of this work was to investigate the structure of nematode community in different types of mature compost. For the purposes of the study, the following types of compost were used: forest origin (KI and KII) and agricultural origin (KIII). The difference between the compost KI and KII was the size of the substrate particles. The results in this work were obtained by field and laboratory studies. The nematode community in the compost types have a difference in their number and species composition. The highest number was recorded in forest compost KII, followed by forest compost KI and the lowest number was in the agricultural compost KIII. The most common were species of *Aphelenchoides*, *Diploscapter*, *Monachoides*, *Cephalobus*, *Ditylenchus*, and *Diplogastrellus* and *Dorylaimus* were only found in the forest compost KI. The biodiversity was greater in the compost KII and lowest in the compost KIII. The results could be used as an estimate of the composting process and the quality of the compost.

Key words: compost, nematode community

Introduction
The striving for continuous improvement in yields requires the use of adverse agricultural practices by farmers. Such practices are unbalanced fertilization, intensive soil tillage, monoculture cultivation and improper use of pesticides that affect negatively and long-term the biological processes in the soil. In monoculture cultivation, the microbial diversity in the soil decreased as a result of one-sided effects of the root mass (Isbell et al., 2011). Thus, degradation of organic matter is slow and the formation of humus is minimal.

The intensive soil tillage destroys the habitat of many organisms of meso- and macro fauna, and they play a key role in maintaining soil fertility. For these reasons, the green manure and the introduction of compost begin to apply.

The use of compost is very beneficial and economical method for improving physical and biochemical properties of soil. Smeding & De Snoo (2003) showed that after adding compost to soil, the multiplication of collembolans and nematodes is increased. The changes in the biochemical composition of the soil leading to changes in the structure and dynamics of nematode communities (Chauvin et al., 2015; Neher, 1999).

The nematodes (free-living and plant-parasitic nematodes) as representatives of the soil mesofauna are the most common used organisms as bioindicators to indicate biological effects of soil factors (Bongers, 1990).

Based on our literature review and the need for research on the influence of compost on phytopathogens incl. phytonematodes in the soil substrate, the objective of this work was to study the structure of nematode community in

SPECIAL EDITION / ONLINE Section “Biodiversity & Ecology”
Second National Youth Conference “Biological sciences for a better future”, Plovdiv, October 30-31, 2015
different types of mature compost.

The determination of the species composition of nematodes before using the compost is an assessment of the ongoing process of composting and essential for agricultural production.

Materials and Methods

The characteristics of the compost

Various types of compost (forest and agricultural) were used for the purposes of the study. The composts in this work will be called conditional: forest compost, type I (KI), forest compost type II (KII) and agricultural compost (KIII).

The wood waste materials from deciduous trees (branches and bark) were used for compost KI and KII as "brown" material (carbon source). The sorted waste materials from the household and freshly mown grass were used as a "green" material (source of nitrogen), and as activator of composting process- forest litter. The difference between the compost KI and KII was the size of the substrate particles. The waste materials from agricultural production were used for KIII, as "green" material was stems of tomatoes and peppers, but as "brown" material shoots of vines, and as activator - soil.

The duration of the composting process was terminated after 145 days, with a temperature peak of 68°C.

Sampling for investigation of compost

Samples were taken from the piles of mature compost. For the representative sample, an amount of about 100 cm³ has been repeatedly taken from all sides of each compost heap to give average sample of 1L. After mixing of composting materials, the samples were placed in plastic bags, sealed and stored in a refrigerator at 4-5°C to carry out laboratory analysis. This is important because the density of the compost is different (Buckman and Brady, 1969).

Extraction of the nematodes

After mixing the samples, the average samples of 100 cm³ were determined by means of a measuring cylinder. The resulting quantitative and qualitative data was related to this volume. The methods for the extraction of the nematodes from the soil and roots and their subsequent mounting on permanent slides for identification are according to the Baermann pan method described by Townshend (1963). In addition, the samples were examined for the presence of cyst nematodes by flotation methods.

Quantitative and qualitative assessment of nematodes

The liquid nematode suspension was filled to 100 ml with water to include the number of extracted individuals. The suspension was transferred (5 times per 1 ml) into Bogorov Modified Counting Chamber. Initially, all nematodes were counted under stereomicroscope and the plant parasitic nematodes were separated at recount. The average number of live nematodes in the sample (100 cm³) in the starting suspension of 100 ml was determined by Peters (2003). Species characterization and identification were based on morphology of various life stages (Handoo & Golden, 1989; Andrassy, 1998; Ruess, 2003; Holovachov et al., 2007; Castillo & Vovlas, 2007) Due to the complexity of the process of identification, the some extracted nematodes were determined up to genus level.

Results

Quantitative and qualitative analysis of nematode community

The height number of nematodes were found in the forest compost (KII), followed by forest compost (KI) resp 204 and 433 nematodes per 100 cm³ compost. The lowest was the number of nematodes in agricultural compost (III), 141 nematodes per 100 cm³ compost. After peak temperature, the number of nematodes is gradually increased until the end of the process. Supposedly that the established nematodes have reached their maximum number in the final of composting process. A total of 12 species belonging to 9 families were identified in samples of the various types of compost. Separates samples are characterized by relatively few taxa to 4 genera. The most common are species of Aphelesenchoides, Diploscapter, Mononchoides, Cephalobus, Ditylenchus.

Other taxa, such Diplogastrellus and Dorylaimus, occur infrequently and were only found in the forest compost KI. The nematodes found in the composts are presented in Table 1.

The plant parasitic nematodes were not found, except in the agricultural compost, which after analysis of incubated on agar samples were established 2 individuals of the genus Tylenchus and 1 individual of Paratylenchus, which have a slight pathogenicity in plants (Table 1 and Figure 1).
Table 1. Nematodes established in research compost.

<table>
<thead>
<tr>
<th>Taxon</th>
<th>Feeding type*</th>
<th>Types of compost</th>
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<tbody>
<tr>
<td></td>
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<td>Forest I</td>
</tr>
<tr>
<td>Dorylaimus sp.</td>
<td>1</td>
<td>+</td>
</tr>
<tr>
<td>Aphelenchoides sp.</td>
<td>2</td>
<td>+</td>
</tr>
<tr>
<td>Aphelenchoides composticola</td>
<td>2</td>
<td>+</td>
</tr>
<tr>
<td>Diplogasterellus sp.</td>
<td>1-5a</td>
<td>+</td>
</tr>
<tr>
<td>Mononchoides sp.</td>
<td>1-5a</td>
<td>+</td>
</tr>
<tr>
<td>Cephalobus sp.</td>
<td>1</td>
<td>+</td>
</tr>
<tr>
<td>Ditylenchus sp.</td>
<td>2</td>
<td>+</td>
</tr>
<tr>
<td>Ditylenchus myceliophagus</td>
<td>2</td>
<td>+</td>
</tr>
<tr>
<td>Ditylenchus filimus</td>
<td>2</td>
<td>+</td>
</tr>
<tr>
<td>Tylenchus sp.</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>Paratylenchus sp.</td>
<td>3</td>
<td></td>
</tr>
</tbody>
</table>

* 1= bacterial feeder, 2=fungal feeder, 3=plant parasitic, 4=omnivore, 5=predator and 1-5a= bacterial feeder-predator (ingester) (Yeates et al., 1993).

Figure 1. Relative proportion of the nematode genera in the three compost types.

Discussion

The results obtained in this study describe the structure of the nematode community in the mature compost derived from various organic residues. They relate to changes in species composition that occurred during the composting process. Many authors suggest the use of nematode communities as powerful tools for process analysis and quality of the ecosystem (Bongers & Ferris, 1999; Ferris et al., 2001; Neher, 2001; Ferris & Bongers, 2009; Yeates et al., 2009, Steel, 2010). The composting process is an example of ecosystem in transition, which can be assessed on the basis of inhabiting nematodes. The process in the compost differs from the degradation processes in soil, where Neodiplogastridae (Mononchoides) dominated in the beginning (Georgieva et al., 2005). The mature compost is rich in organic matter, bacteria, fungi and different species of nematodes, which enables the multiplication of Mononchoides sp. In the end of the maturation process of compost, the majority of occurrences of nematodes feeding on mycelium can be linked with the transition from bacterial activity at the beginning of composting to increase the fungus activity at the end of process (Ryckeboer et al., 2003). It is known that the fungal energy channels prevail while the organic material has a high value of the ratio C/N and, conversely, bacterial decomposition channels predominate when the organic material is of a low C/N ratio (Ruess, 2003; Ruess and Ferris, 2004). In a study by Ferris and Matute (2003), the shift in the nematode community structure from bacterivorous to fungivorous increased in plots with a high...
ratio of C/N. According to the bibliographic information, similar taxa in the compost are observed and described by (Gagarin 2000; http://www.soilfoodweb.com). The majority of species in different compost types belong to the family Rhabditidae genus *Cephalobus*, *Rhabditis* and family Diplogastridae, genus *Diploscapter*, *Aphelenchoides* and *Ditylenchus*. These results are in agreement with other authors' observations observations on compost: *Ditylenchus filimus* in West Canada (Anderson, 1983), *Halicephalobus gingivalis* USA (Nadler et al. 2003) and *Rhabditis* (Poikilolaimus) sp. in Russia (Gagarin, 2000). It is remarkable that the same genera even the same species found in studies, regardless of geographic location and origin of material. Although the nematodes do not experience the temperature peak at the time of composting, the "settling" can be done in various ways, such as "contamination" from the soil or by insect (Hodda et al. 2009).

The identified species of the family *Diplogasteridae* are known as predators of plant parasitic nematodes (Khan & Kim, 2007) and therefore are very promising beneficial species for biological control (Bilgrami et al., 2005; Bilgrami, 2008). This study verified the final phase of the composting process in the three compost types.

The resulting types of compost can provide a wide range of potential beneficial nematode species, which are an important factor in determining the suppressing potential of compost to the disease and pests in plants.

References


