Fertilization and field crops effect on earthworms

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Soil quality can be estimated through soil chemical, physical and biological properties, from which the detection of biological indicators is the most difficult. Usually the earthworms are the easiest detectable species to evaluate sustainability of soil biota on arable land. Naturally the abundance and species diversity of earthworms is connected with soil type, water regime, plant cover and temperature. However, earthworm habitats are largely influenced by agricultural activities such as fertilisation, soil tillage, use of pesticides and cultivation practice (organic or conventional farming), crops grown. The main influence of these practices is through the destruction of habitat; change the soil organic matter content, water regime and reaction of soil.
The aim of current study was to investigate different fertilization schemes under conventional and organic farming practices, including, effect on earthworms abundance, biomass and species diversity. Data were collected in autumn of 2012–2016 from a 5-year crop rotation experiment (*Pisum sativum* L., *Solanum tuberosum* L., *Hordeum vulgare* L. undersown with *Trifolium pratense*, *Trifolium pratens* L., and *Triticum aestivum* L.), established in Estonia near Tartu on sandy loam *Albic Stagnic Luvisol* in 2008. This rotation was managed under 5 farming systems, two conventional: Conventional I (not fertilized but with addition of chemical pesticides) and Conventional II (mineral fertilized plots with a final fertilization rate of $N_{150}P_{25}K_{95}$ plus the addition of chemical pesticides); and three organic: Organic 0 (without any fertilization), Organic I (with winter cover crops used lately as green manure) and Organic II (plots with the same cover crops plus a yearly amendment of 40 t ha^{-1} of cattle manure*). Brassica rapa* L. subsp. *oleifera*, *Secale cereale* L. and their mixture were used as cover crops. The use of pesticides was according to the culture and need, mainly herbicides and fungicides were used. The plots were ploughed at 22 cm depth, cultivated at 10–12 cm and harrowed at 4–5 cm depth. Earthworms were collected from humus layer of the soil (20 cm) from the area 40 x 40 cm, than counted by species and weighted.

The dominating species on all treatments were *Aporrectodea caliginosa* L. and *Lumbricus rubellus* L. Only some individuals of *Aporrectodea rosea* L. and *Allolobophora chlorotica* L. were found under conventional farming in both fertilization treatment, but they were found almost on every plot under Organic I and II treatments. As it was expected, the highest number and biomass of earthworms was by using cattle manure (Figure 1). However, as the residues goes back into the soil in this experiment, there was no significant differences in earthworm abundance and biomass between highly fertilized conventional treatment and organic treatments with cover crops. The used crops influenced the earthworms more than cultivation practice – it had a statistically significant impact on their abundance and biomass. The earthworms were more abundant and their mass bigger in the test plots with red clover and pea as legume crops create more favourable habitats for earthworms. The earthworms were least abundant and had a smaller mass in the field where potato was grown due to intensive tillage. Similar results were observed in the plots with barley and clover undersowing. The small number and biomass of earthworms in the mentioned fields was because legume crops were not grown as pure cultures. Besides the main crops winter cover crops had an influential role. Growing winter cover crops as green fertilisers had a favourable effect on earthworms as in the organic plots the number, biomass and variety of earthworms was bigger. Earthworms favoured red clover and pea and less potato and barley.

The results revealed slightly improving effect of organic farming on earthworms, but the main factor seems to be the availability of suitable food (plant residues, manure) than farming practice itself.

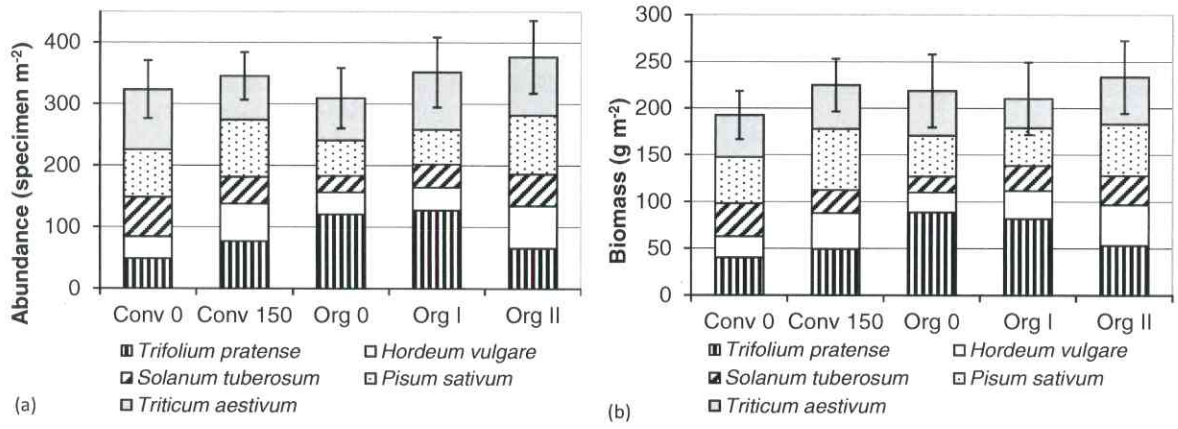

Figure 1. *Abundance (a) and biomass (b) of earthworms depending on fertilization and management practice. Conv 0 –, conventional; Conv 150 – fertilization $N_{150}P_{25}K_{95}$, conventional; Org 0 – without fertilization, organic; Org I – with winter cover crops, organic; M II – with winter cover crops + 40 t ha^{-1} cattle manure, organic. Vertical bars denote standard terror of the mean.*

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