Effect of repeated anaerobic digestates applications on earthworm communities

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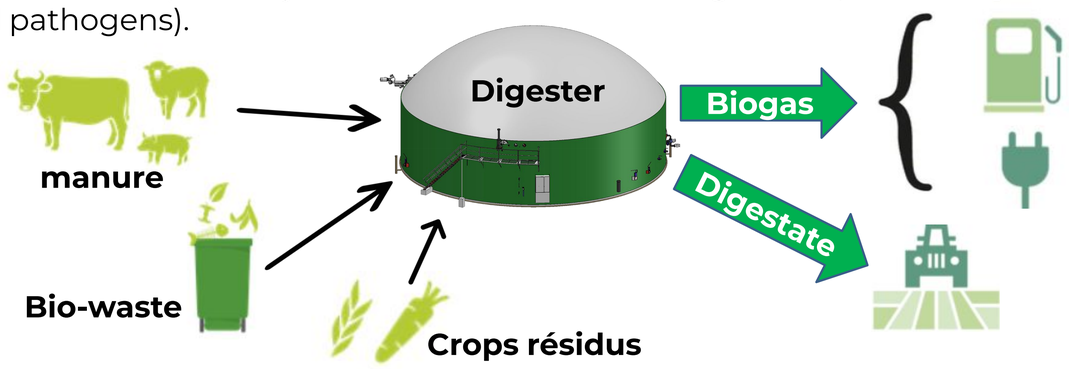
Introduction

Intensive livestock farming, annual crops or cities can produce a large amount of organic waste such as slurry, manure, sewage sludge or compost. These wastes are mostly used as organic fertilizers for crops, but their use by farmers is limited by legislation due to environmental issues. Thus, this organic waste is sometimes difficult to exploit.

Anaerobic digestion is increasingly used in Europe to treat organic substrates and produce biogas as a renewable energy source. The residual matter (digestate) is used in agriculture as an organic fertilizer (Moinard *et al.*, 2021). Depending on the technology used (solid, liquid, crude) the digestate contains nutrients that can be used as an alternative to mineral fertilizers on crops (Riva *et al.*, 2016) and can offer a solution in waste management. However, the response of soil biological communities to anaerobic digestate is not fully understood (Natalio *et al.*, 2021).

The Metha BioSol project aims to evaluate the impact of anaerobic digestates on the chemical, physical and biological soil properties with a wide range of bio-indicators (diversity of soil fauna and micro-organisms, carbon dynamics and pathogens).



What are the effects of anaerobic digestate, on earthworm community parameters (Total abundance, functional group and richness)?

Materials & methods

Location of the experimental sites & Modality tested

In each experimental site, treatments were distributed in a randomized block design

DIGLiger	DIGTrubert	DIG-PM	CM	PM	MF
Digestate of pig manure +plant+grease + sludge	Digestate of cattle manure and slurry +plant	Digestate of pig manure	Cattle manure	Pig manure	Mineral fertilizer

CM	BW	SS	DIG	WF
Cattle manure	Bio-waste (compost)	Sewage sludge	Digestate of bio-waste, manure, plant	Without fertilizer

Digob	Dig+clay	MethaC	CM	MF
Digestate of bio-waste, cattle manure, plant	Digob +clay	Digestate bio-waste, cattle manure, plant	Cattle manure	Mineral fertilizer

Site 1: EFELE
Number of blocks: 4
Soil type: luvisoil redoxisoil
Organic matter: 2 %
Soil pH: 6,2
Climat: oceanic climate
Crops: maize-wheat (or maize-barley)

Site 2: PROSPECTIVE
Number of blocks: 4
Soil type: calcareaous silty-clay
Organic matter: 2,4 %
pH: 8,3
Climat: semi-continental
Crops: maize, wheat, sugar beet, barley

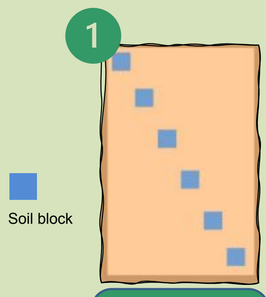
Site 3: DIGE'O
Number of blocks: 3
Soil type: calcareous clayey silt
Organic matter: 3 %
Soil pH: 8,4
Climat: semi-continental
Crops: maize-wheat-maize

Earthworm sampling campaign took place in 2022 on three experimental sites in France:
-EFELE: INRAe, Rennes, set up in 2012
-PROSPECTIVE: INRAe, Colmar, set up in 2015
-DIGE'O: Agricultural high school in Obernai, set up in 2018

Earthworm sampling with the spade test

Simplified protocol of ISO 23611-1:2018

1. Delimit the sampling area along the diagonal



2. Extract 6 blocks of soil (20 cm × 20 cm × 25 cm, length × width × depth), according to the size of the plots

3. Blocks of soil are meticulously hand-sorted

4. The earthworms are put in 96% ethanol

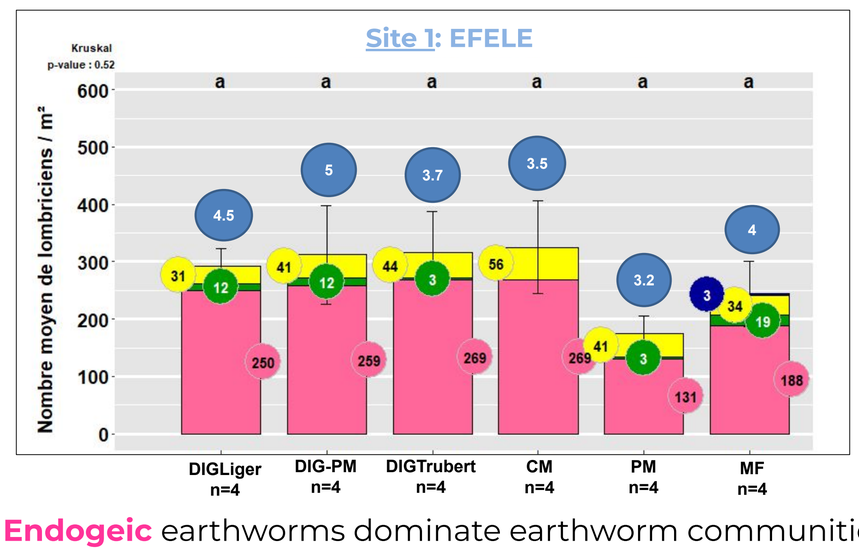
5. Earthworms' species are identified in the laboratory

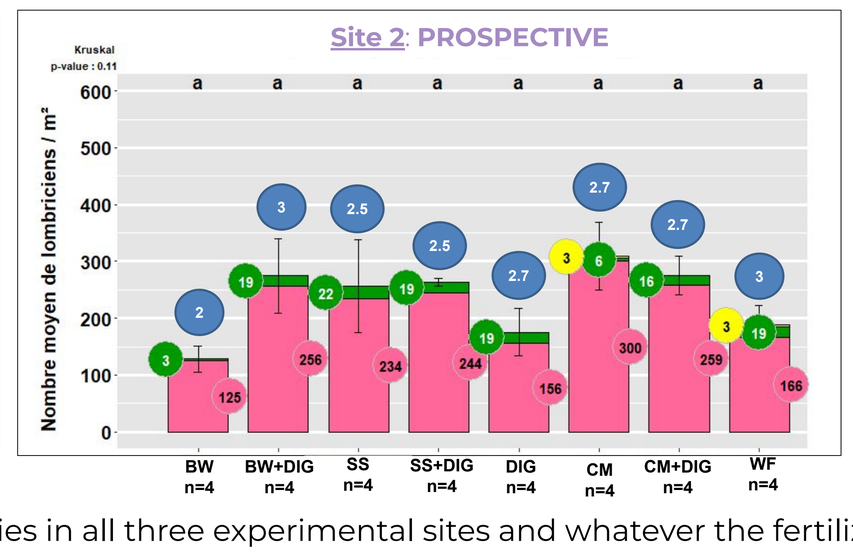
Results & Discussion

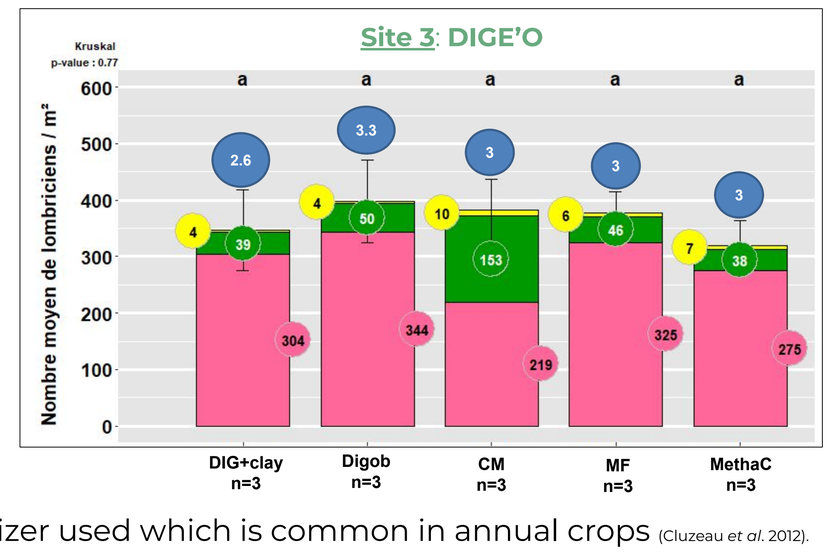
Endogeic
Aporrectodea anecic
Lumbricus anecic
Epigeic

Comparison of the effect of digestate on earthworms with other organic fertilizers

Mean richness







Endogeic earthworms dominate earthworm communities in all three experimental sites and whatever the fertilizer used which is common in annual crops (Cluzeau *et al.* 2012).

Preliminary results shows that earthworm abundance and richness were not significantly different among the digestates compared to control fertilizers (CM, PM, BW or MF).

These results are in line with previous studies, for example, Froseth *et al.* (2014) observed that green manure digestates had no effect on earthworm communities and Koblenz *et al.* (2015) observed that overall, the application of pig manure digestate no effect on the biomass and abundance of earthworms.

However, contrary to these results, other studies observed that the abundance of earthworms, especially the juveniles, decreased after application of digestate (Natalio *et al,.* 2021; Moinard *et al.,* 2021) probably due to ammoniacal toxicity.

First Conclusions

Across three experimental sites, earthworm **abundance and richness** were not impacted by digestates (compared to mineral or manure fertilizer).
However, it would also be interesting to test the impact of digestates on other parameters such as **biomass**, **diversity index** or **individual weight.**

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