Hidden Heros

Sarah Symanczik, Dominika Kundel, Meike Grosse, Sophie Van Geijtenbeek (FiBL)

Organics Europe Youth Event: Workshop “Hidden Heroes” 01.09.2022
Program

- Block 1: Importance and diversity of soil and soil microbes
  - Group work Think-pair-share: what are microbes doing in the soil?
  - Soil functions, structure, soil biodiversity
- Block 2: Taking a closer look
  - Spotlight on plant symbionts
  - How to study soil microbes – case study the BIOFAIR project
- Break
Program

• Block 3: Managing soil microbes
  • Discussion round: how are soil microbes affected by agricultural management?
  • How to promote soil microbes
  • Reduced tillage with Frick trial as case study

• Block 4: Using soil microbes
  • 15’ Biofertilizers: How to produce, benefits and drawbacks
  • 15’ the compost microbiome

• Block 5: Final discussion
Block I

Importance and diversity of soil and soil microbes
Group work: Think – Pair – Share (10’)
What is the role of microbes in the soil?
Soils fulfil multiple functions and people are influenced by and depend on soils in many ways.

The concept of ecosystem services shows how soil functions are linked to human well-being.
Ecosystem services

- Ecosystem services are “Gifts from nature”
- Soil scientists divide these into 4 areas (MEA, 2005; Baer and Birgé, 2018)

- Provision of food, water, building materials (wood), fibres
- Raw materials for medicines
- Degradation of pollutants
- Climate regulation
- Drainage of surface water
- Pest control
- Water quality

- Soil formation
- Nutrient cycle
- Preservation of genetic diversity
- Promotion of plant growth
- Recreation
- Nature tourism
- Aesthetic enjoyment
- Spiritual fulfilment

https://soilmatter.wordpress.com/2016/12/15/the-soil-provides-services-to-me/
Art: P Scullion
General composition of soils

- **Mineral matter** ~ 40 to 45%
- **Water** ~ 25%
- **Air** ~ 25%
- **Organic matter** ~ 5%
- **Stabilized organic matter (humus)** ~ 35 to 50%
- **Fresh residues** ~ 10%
- **Decomposing organic matter (active fraction)** ~ 35 to 50%
- **Living organisms** ~ 5%

→ 5% of the soil organic fraction (=0.25% of total soil) consists of living organisms
→ healthy soils are alive and harbour around 25% of the biodiversity on our planet
Soil biodiversity

(derived from Swift et al., 1979).
Soil biodiversity

- **Mikroorganisms** [1, 2] (only 1% of species are described!)
  - Bacteria
  - Archae
  - Fungi/Mycorrhizal fungi
  - Aktinomycetes
  - Algae
  - Protozoa


https://www.globalsoilbiodiversity.org/atlas-chapter-2
You can find more microorganisms in a teaspoon of soil than people on this earth.

<table>
<thead>
<tr>
<th>Group</th>
<th>Number/g soil</th>
<th>Biomass (g/m²)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bakteria</td>
<td>$10^8$–$10^9$</td>
<td>40–500</td>
</tr>
<tr>
<td>Aktinomycetes</td>
<td>$10^7$–$10^8$</td>
<td>40–500</td>
</tr>
<tr>
<td>Fungi</td>
<td>$10^5$–$10^6$</td>
<td>100–1500</td>
</tr>
<tr>
<td>Alga</td>
<td>$10^4$–$10^5$</td>
<td>1–50</td>
</tr>
<tr>
<td>Protoza</td>
<td>$10^3$–$10^4$</td>
<td>varying</td>
</tr>
</tbody>
</table>

Soil microbes in action

- Biological N fixation
- Decomposition of organic matter
- Recycling of nutrients
- Formation of humus
- Soil structure formation
- Decomposition of pollutants
- Pest and disease defence
- Plant growth promotion

Soil microbes play a crucial role in various processes, enhancing soil fertility and ecosystem health.
Block 3
Einfluss der Landwirtschaft auf Bodenmikroben
Group work: Think – Pair – Share (10 min)

How does agriculture influence soil microbes?
What agricultural practices support soil microbes?
Impact of different farming systems on soil microorganisms: Meta-Analyse von Lori et al. 2017

Impact of different farming systems

Positive effects on soil microbes through:

• Diverse crop rotations (with legumes)
• Organic fertilisers
• High organic carbon content

Influence of above-ground diversity on soil microorganisms: meta-analysis by Chen et al. 2019

Monocultures vs mixed-cropping systems

<table>
<thead>
<tr>
<th>Size</th>
<th>Activity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Microbial biomass</td>
<td>416 (96)</td>
</tr>
<tr>
<td>Bacterial biomass</td>
<td>127 (31)</td>
</tr>
<tr>
<td>Fungal biomass</td>
<td>126 (31)</td>
</tr>
<tr>
<td>Microbial respiration</td>
<td>186 (33)</td>
</tr>
<tr>
<td>Metabolic quotient</td>
<td>156 (24)</td>
</tr>
</tbody>
</table>

Review of meta-analysis on the influence of plant charcoal on soil microorganisms

Pockarel et al. (2020)  Soil microbial biomass C
Zhang et al. (2018)  Total PLFA
     Bacteria
     Fungi
Zhou et al. (2017)  Soil microbial biomass N

Mean effect size (%) ± 95% CI

Influence of tillage on soil microorganisms: meta-analysis by Chen et al. 2019

Chen et al. Global meta-analyses show that conservation tillage practices promote soil fungal and bacterial biomass. *Agriculture, Ecosystems & Environment 293 (2020)*