Practice Abstract n°7 : CLIMECS Experiments

CLIMECS (CLImatic Manipulation of ECosystem Samples) is a mesocosm test system, originally developed to study the effects of climate change on soil ecosystems under simulated natural conditions. Within the PAPILLONS project, the CLIMECS system is used to study the effects of microplastics under more realistic, but still well-controlled conditions, as an intermediate step between single-species toxicity tests and field-plot experiments.

1. Use of controlled laboratory conditions

CLIMECS combines different species of soil organisms, representing different trophic levels, in a natural soil, to simulate the conditions in soil ecosystems. And by its unique capacity of controlling abiotic conditions like temperature and humidity, it allows studying both the direct and indirect effects of microplastics on different biotic and abiotic parameters. CLIMECS also provides a unique tool to study the fate of microplastics in soil, alone or in interaction with soil organisms. The results of these studies, will be published as scientific journals.

2. Focus and significance of the experiment

The CLIMECS experiments conducted as part of the PAPILLONS project aim to understand the effect of microplastics on soil ecosystems as well as their fate in soils under the influence of variable watering regimes and in the presence of earthworms. By deploying soils spiked with microplastics mimicking situations commonly encountered in agri-environments, fate and effects are studied under more realistic conditions. Two CLIMECS experiments were performed to assess the effects of microplastics derived from a biodegradable and from a conventional non-biodegradable mulching film on soil organisms. The experiments included a comprehensive assessments of the effects of microplastics on soil physico-chemical properties, as well as on microbial activity, microbial community, soil invertebrates and plant growth. A 3rd experiment aimed to assess the transport of microplastics and additives in soil, under the influence of earthworm activity and watering regimes.

3. CLIMECS 1: effects of microplastics on plant growth (01/2022 - 06/ 2022)

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Objective: Analyze the effects of degradable MPs on soil organisms (springtails and earthworms), the growth and defense mechanisms of lettuce (Lactuca sativa), soil microbial activity and several abiotic parameters like soil pH and soil aggregation. The experiment used a biodegradable plastic mulching film, PBAT, to produce microplastics. These microplastics were incorporated into a natural standard soil at different concentrations, ranging from 0% to 0.8% of the dry weight of the soil. The results revealed significant impacts on soil abiotic conditions, lettuce growth and defenses, and microbial activity and microbial community composition.

4. CLIMECS 2: transport of microplastics in soil (11/2022 -02/2023)

Objective: Study the transport of microplastics in soil, taking into account factors such as the presence of earthworms and the intensity of precipitation. Microplastics, produced from both degradable (PBAT-based) and conventional non-degradable (PE-based) mulching films, were introduced at different concentration into the 10 cm topsoil layer of 40cm columns, simulating field conditions.

5. CLIMECS 3: ecotoxicological effects of microplastics

Objective: assessing the ecotoxicological effects of conventional non-degradable microplastics on soil ecosystems under simulated natural conditions. Microplastics produced from non-degradable (PE-based) mulching film were mixed in with natural soil at different concentrations between 0% and 0.8%. For the sake of comparison with the first experiment, also one treatment with 0.8% degradable (PBAT) microplastics was included.

6. Future implications

By elucidating the complex interaction between microplastics, soil organisms and environmental conditions, this research provides important information for the assessment of the potential risk of microplastic pollution to soil health and ecosystem functioning, and may help defining risk limits. Furthermore, the success of CLIMECS underlines the immense potential of innovative experimental approaches in advancing our understanding of ecosystem responses to environmental stressors under simulated natural conditions.

The work using the CLIMECS system is supervised by Professor Emeritus Kees van Gestel, and conducted by Vrije University in the Netherlands.

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