Practice abstract n°17: Effects of micro- and nanoplastics on plants – Field plot study

The PAPILLONS consortium conducted a field experiment to study the effects of micro- and nanoplastics (MNPs) on crop production and quality, aiming to uncover whether MNPs impact plant performance. Researchers investigated how these particles affect plants at different stages of their development and how well plants grow and function when they are exposed to MNPs through the soil. More specifically, the study examines the ways in which recycled MNPs affect barley growth, yield, and physiological responses in real farming conditions across three European countries: Spain, Germany, and Finland.

Methodology

These locations were **chosen to represent a range of European agro-ecological zones, including differences in climate, soil type, and vegetation**. During the field experiments, two types of MNPs were tested: conventional polyethylene (PE) and a biodegradable starch-PBAT blend. Each was applied at two different concentrations—0.005% and 0.05% by soil dry weight—reflecting pollution levels commonly found in European farmland.

Malting barley, commonly cultivated in all three regions, was planted in all the examined fields during the 2022 and 2023 growing seasons. Researchers collected samples at different stages of plant growth to assess leaf characteristics, chlorophyll content, and signs of plant stress. At harvest, they measured grain yield and the harvest index (HI) —a measurement of crop yield— to determine overall crop performance.

This setup **allowed scientists to evaluate the effects of MNPs over time and in different environments,** providing insights into how plastic pollution might influence crop health and productivity.

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Main results

- **Growth** and yield: **No consistent effects** of MNPs on overall barley growth and yield were observed across all sites. However, the harvest index and biomass data **suggested site-specific variations.** For example, slight yield differences occurred between Germany and Finland, but were not statistically significant.
- **Chlorophyll** content (a key marker of plant health and photosynthesis) was **reduced** in plants exposed to higher levels of MNPs, especially at the 0.05% concentration. The decrease in chlorophyll was more pronounced in Spain, possibly due to warmer and drier conditions strengthening MNP effects.
- **The levels of stress increased** with MNP exposure, particularly at higher doses. This implies that MNPs induced stress in the plants, though responses varied by region and year.
- The **duration** of exposure (1 vs 2 years) **significantly impacted plant responses**—effects were more apparent in the second year.
- **Local soil** and climate conditions (pedoclimatic factors) **played a major role** in how strongly barley responded to MNP exposure.

Conclusion

While barley yield remained relatively stable across treatments, clear physiological and biochemical changes were observed due to MNP exposure, especially at higher concentrations and over longer periods. These changes include reduced chlorophyll levels, increased oxidative stress, and activation of plant defence systems. Effects varied significantly between countries, showing that local climate and soil conditions influence how crops respond to plastic pollution.

Overall, the study confirms that MNPs can subtly affect crop health even under real-world conditions, highlighting the need for regulation and long-term monitoring of plastic use in agriculture.

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