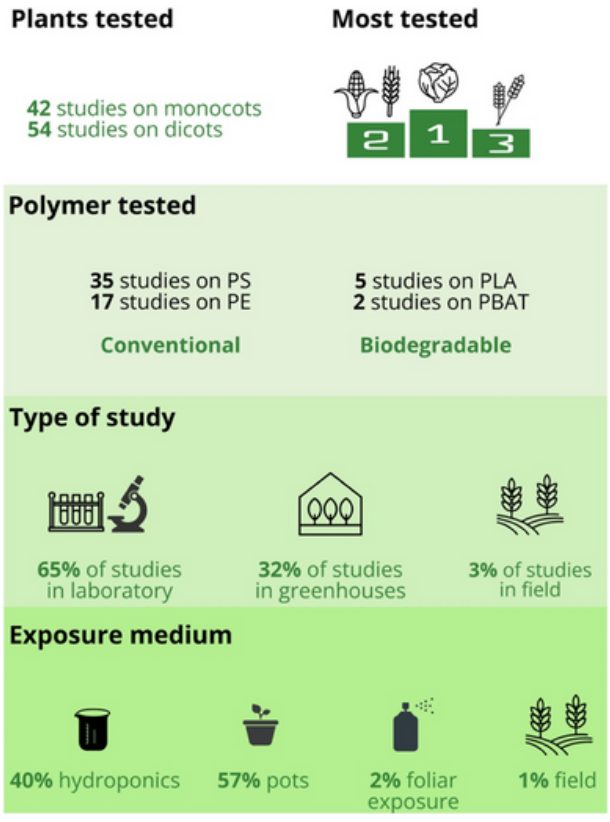
Practice Abstract n°6 : Micro and nanoplastics have negative effects on plants: a systematic review

Micro & nanoplastics (MNPs) are ubiquitous in the environment, including in agricultural soils. To date, levels of MNPs have been estimate to be between 0.00014% and 6.75% w/w. Plastic pollution enters soils via a range of different pathways, including agricultural plastics, biosolids and atmospheric deposition. This raises concerns about their potential impact on soil structure and the organisms that depend on it, including plants. MNPs can be absorbed by plants and transported from their roots to their leaves. Understanding these effects is crucial given the fundamental role of plants in the food chain and for food security.

1. Methods and materials

A systemic literature review was conducted to synthesize our current knowledge on the effects of MNPs on terrestrial plants. A total of 78 articles were identified, and we extracted data on seed germination, plant growth and biochemical responses. The aims of this in-depth analysis were to provide a summary of our current understanding of the interactions between MNPs and terrestrial plants, and to identify research gaps to guide future studies on this topic.



2. Results and discussion

Study focus

A total of 96 experiments (54 experiments on dicots, and 42 on monocots) were included in the review, with a particular focus on agricultural crops such as lettuce, wheat, maize and rice. The conditions of exposure to MNPs varied, with the majority of studies carried out in the laboratory (51 publications). The most commonly tested polymers are polystyrene (PS) and polyethylene (PE), and MNPs particle sizes range from nanoplastics to microplastics.

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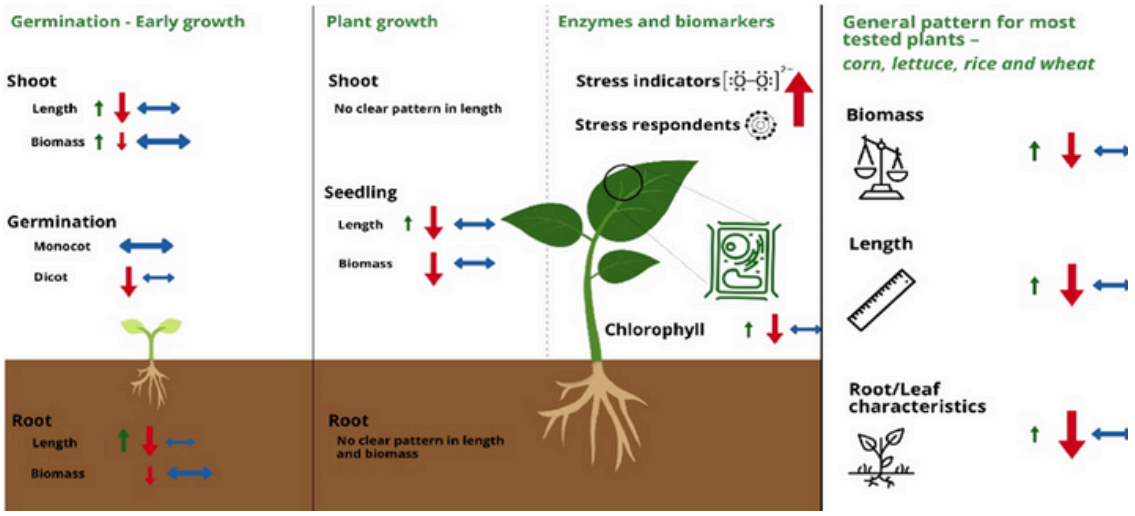
Effects on plants

A range of impact of MNPs on plants, ranging from effects on seed germination, root and shoot length, and plant biomass were identified.

- Germination and early growth, shoot and root length were sensitive endpoints, often negatively impacted after exposure to MNPs. In dicot plants, germination was often inhibited, however, this was not the case for monocot plants (most likely due to a difference in seed size)
- In plant growth, the seedling showed a decrease in length and biomass, but no pattern in shoot or root growth was observed.
- Looking at stress response, stress markers were consistently upregulated, suggesting an increased level of stress.

In many cases these effects are observed at environmentally relevant exposure concentrations, meaning that the current levels of exposure could induce impacts on plants.



3. Conclusion

Biomarker responses are consistent with the hypothesis that MNPs negatively impact plants, even though different indicators react in different ways. Several key research gaps need to be addressed to fully understand the impact of MNPs: there is an urgent need to study MNPs effects under realistic environmental conditions accounting for the effects of additives on plant performance and biodegradable plastic. The uptake and fate of MNPs in plants, as well as their movement through the food chain and the associated ecological and health effects require more in-depth investigation.

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