

Influence of microplastics on the germination of ryegrass

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1. Introduction

- Plastic production, littering and mismanaged plastic debris are constantly increasing, resulting in all-size plastic accumulating in the environment
- Recently, microplastic (< 5 mm) and nanoplastic came into the spotlight of scientific interest
- They do not only affect marine compartments
- These particles are also increasingly entering and persisting in all terrestrial compartments
- Indistinct consequences for soil ecosystems
- Knowledge gap on the interaction of microplastic and food-web plants like crops or fodder plants
- Shape and size of plastic particles may determine their consequences for plant performance



Fig. 1: exemplary image of ryegrass growing in northern Germany

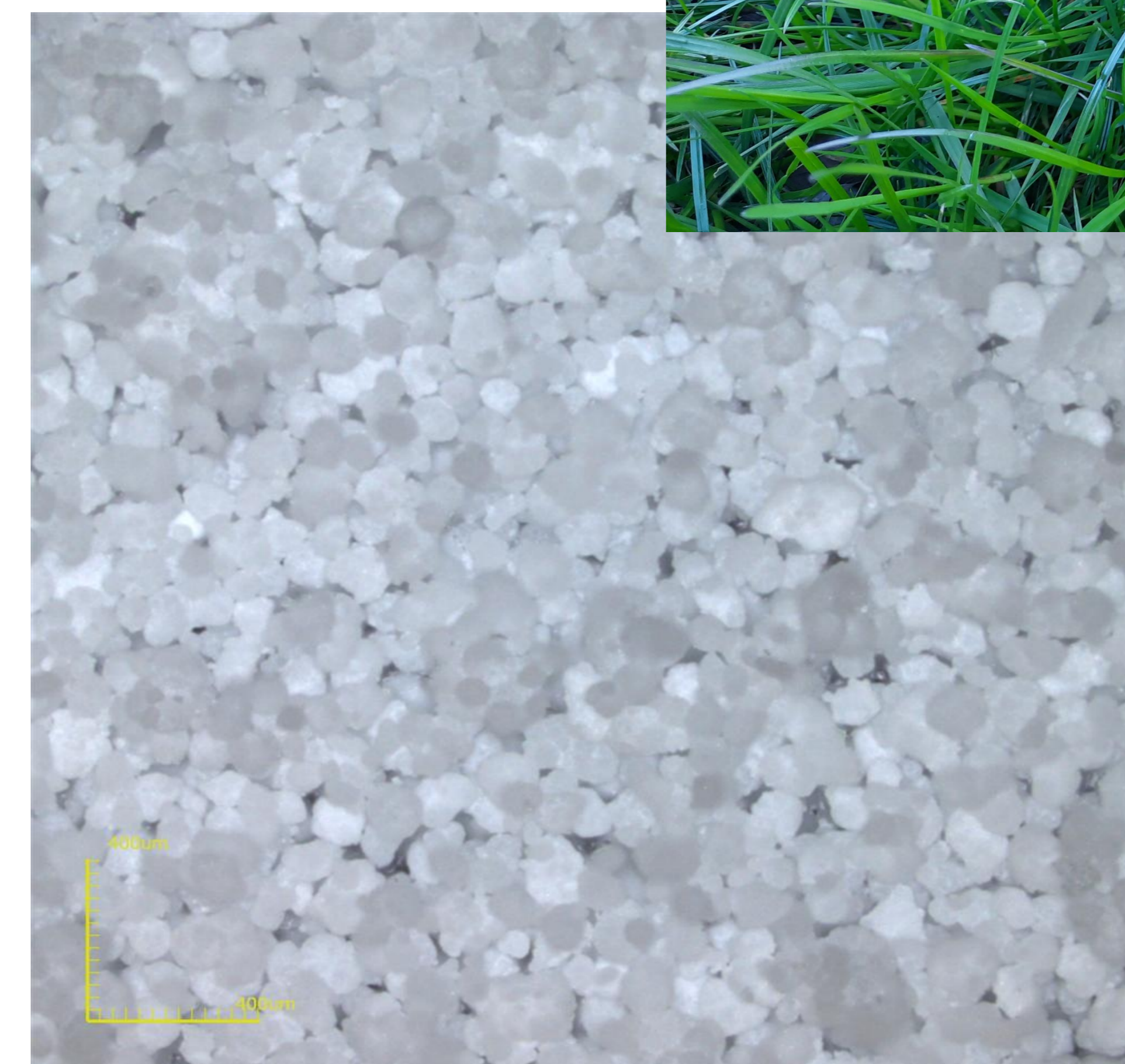


Fig. 2: Exemplary image of industrially produced microplastics (polyethylene). The image was taken with a 5-fold magnification using a confocal laser scanning microscope.

Influence of microplastics on the germination of ryegrass - Materials and Methods

2. Materials and Methods

- Germination trials in petri dishes
- Laboratory conditions (20°C)
- Model plant: *L. multiflorum* Lam. var. *Westerwoldicum*
- Types of microplastic (MP) were:
 1. tyre wear derivatives:
 - W0004 (< 80 – 400 µm); W0610 (600 – 1000 µm); W2550 (< 2000 – 5000 µm)
 2. polyvinylchloride (PVC): 1 – 63 µm
 3. MP-extracts solved in aqua dest.
- Concentration levels: 0 g; 0.5 g; 1 g; 1.5 g; 2 g

Parameter Analysis:

- Germination rate according to ISTA (International Seed Testing Association): normal, abnormal, ungerminated
- Dry matter yield
- Analysis of root parameters
- Isotopic measurements ($\delta^{13}\text{C}$ -signatures)



Fig. 3: Petri dish with seedlings of *L. multiflorum* with PVC-extract



Fig. 4: Petri dish with seedlings of *L. multiflorum* with 0.5 g of W0004



Fig. 5: Seedlings of *L. multiflorum* after germination period of 13 days with addition of PVC. Visual comparison between abnormally germinated seedlings (left) and normally germinated seedlings (right).

Influence of microplastics on the germination of ryegrass - Results

3. Results

- Germination decreased under influence of MP (Fig. 6)
- Large number of abnormal and ungerminated seeds with larger applications of MP (Fig. 6)
- Almost no germination in PVC treatments (Fig. 6)
- Total root length decreased in plants with MP-treatment, most severe for PVC (Fig. 7 and Fig. 8)
- Root lengths least impacted by smallest concentrations and MP extracts (Fig. 7 and Fig. 8)

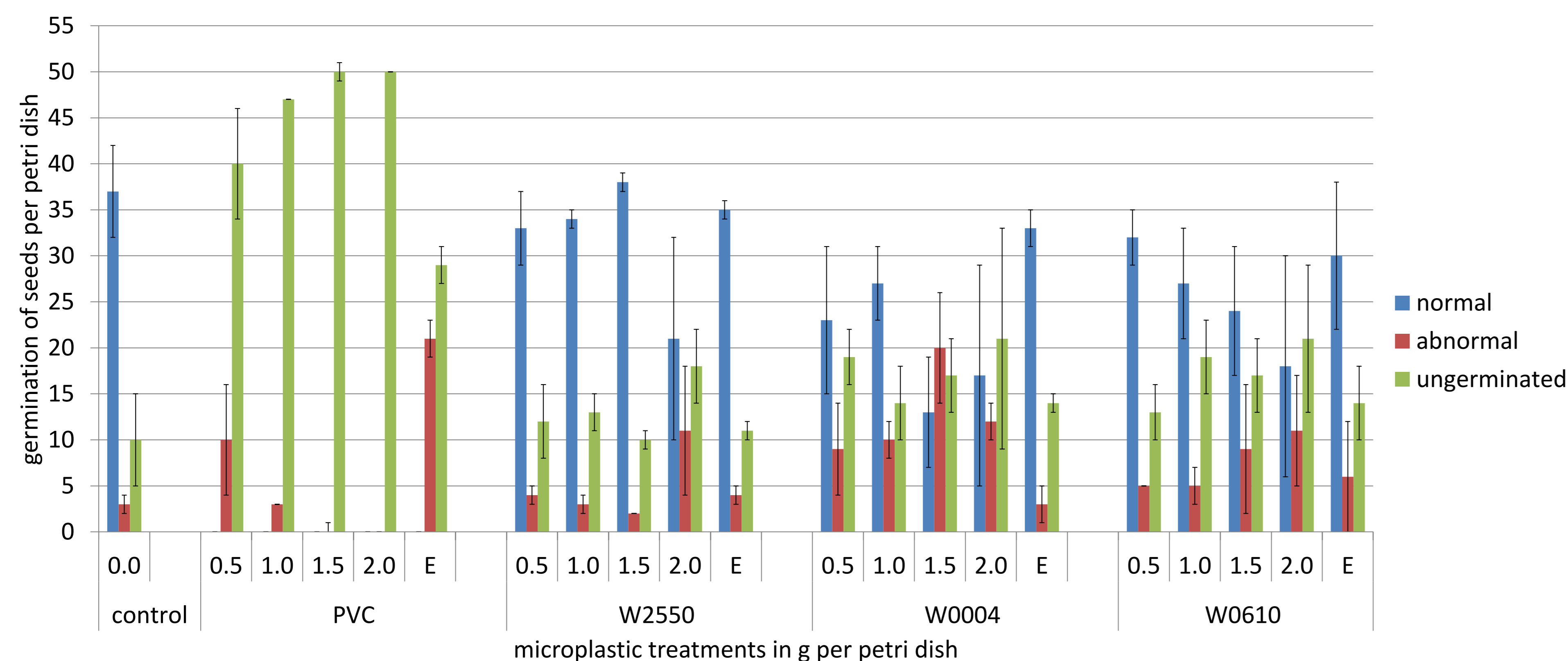


Fig. 6: Germination rate of ryegrass seedlings (50 seeds = maximum), counted according to ISTA (International Seed Testing Association), differentiated into normal, abnormal and ungerminated for microplastic treatments (PVC, tyre wear derivatives (W0004; W0610; W2550), MP-extracts: E) and concentration levels (in g). Mean \pm standard error are presented.

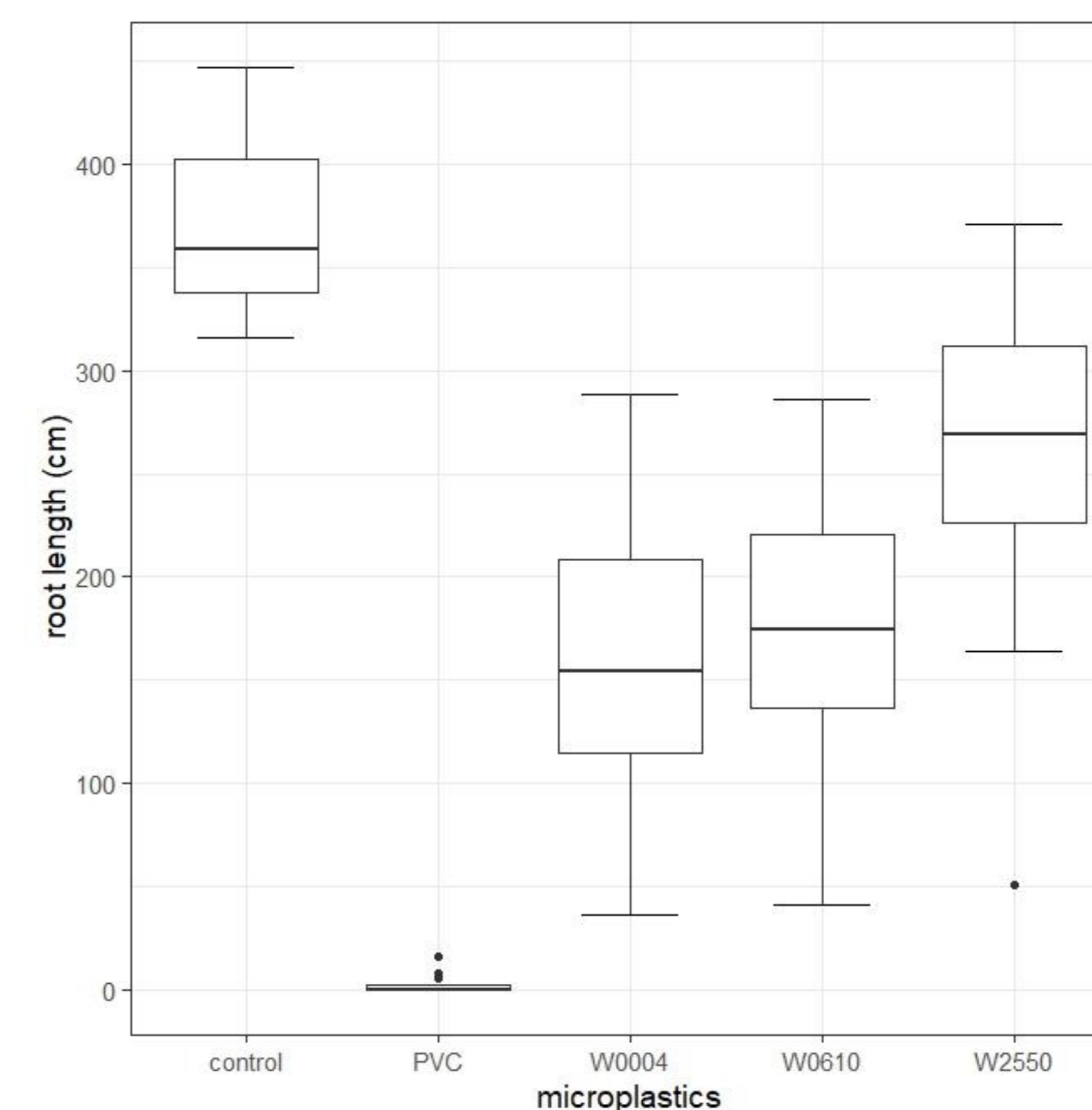


Fig. 8: Total root length in cm, shown in boxplots for the different microplastic treatments (PVC, tyre wear derivatives (W0004; W0610; W2550). Extracts and concentration levels are included)

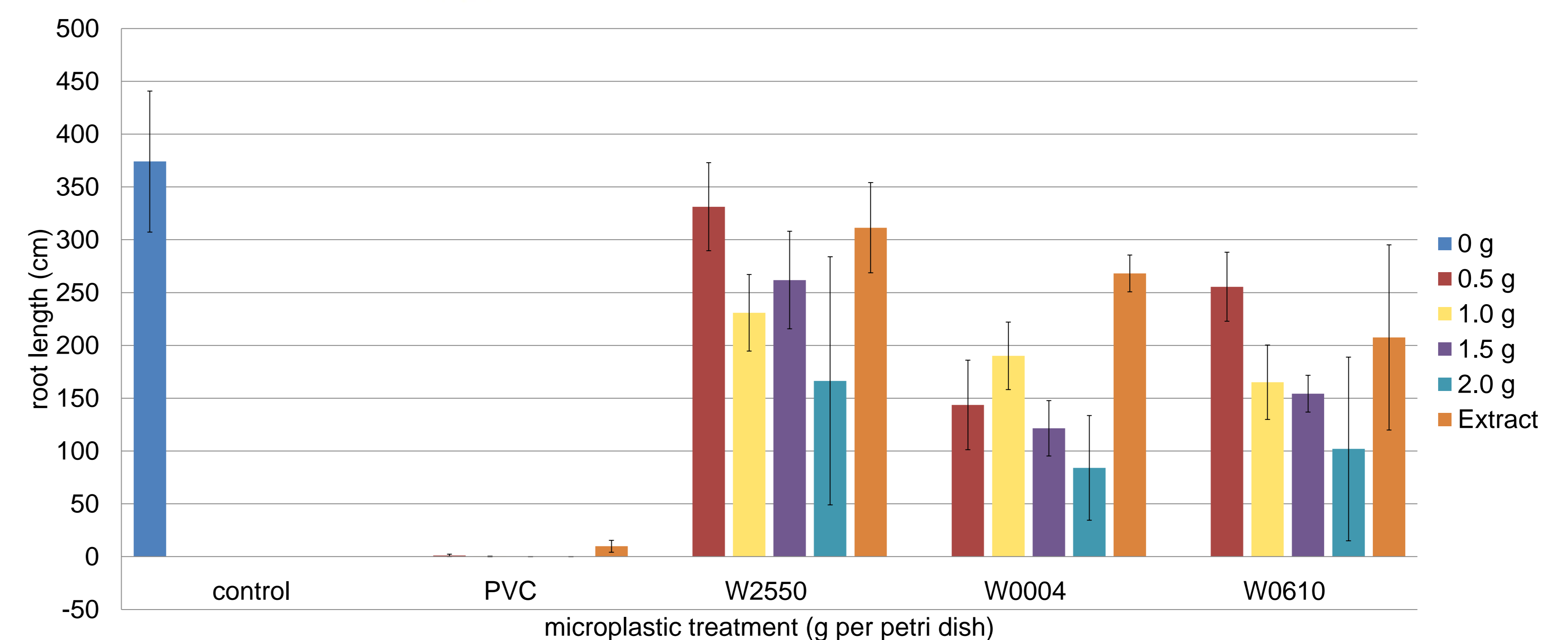


Fig. 7: Total root length of ryegrass seedlings in cm, shown for the different microplastic treatments (PVC, tyre wear derivatives (W0004; W0610; W2550), MP-extracts) and concentration levels (in g). Mean \pm standard error are presented.

Influence of microplastics on the germination of ryegrass - Conclusion

4. Conclusion

- MP impaired germination of ryegrass in most treatments, resulting in a high number of abnormally germinated seeds
- The decrease in plant performance seems to be strongly depending on the type of MP
- There was a tendency towards stronger growth inhibition caused by smaller particles
- Decrease of root lengths of ryegrass may be compensatory behaviour due to an MP-induced dysfunction of the overall plant water balance
- Laboratory conditions are hardly comparable to naturally occurring growth conditions in the fields. Due to the tremendous role of grasslands for feed and food production and the impact on ecological stability
→ we need more knowledge on the detailed processes of plant growth inhibition by MP

5. References

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