Plant Response to Microplastics from Conventional and Biodegradable Mulching Films

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Introduction

Mulching film products have been developed for agriculture and horticulture to facilitate cultivation, reduce the need for plant protection products and improve agriculture profitability. Degradation rate of biodegradable films replacing conventional plastic cover films especially in northern conditions is assumed to be slower than under ideal laboratory conditions resulting in accumulation of plastic particles which act as soil microplastic source. Therefore, it is essential to assess the potential risks for the safe use of these materials and prevent degradation of soil quality and fertility in the long run.

Material and Methods

Effects of mulching film particles (< 3 mm) on Chinese cabbage (*Brassica pekinensis*) seed germination (5 d) and plant growth rate (13 d) was examined using:

- Standardized methodology and controlled conditions
- Three different microplastic types: conventional (PE) and two biodegradable (BIO1 and BIO2) plastics mixed in sieved (2 mm) sandy loam soil
- Two concentrations (0.1% and 1% w/w)
- Three replicate plants for each concentration
- Cellulose powder as positive control

Biotests were performed on two separate occasions:

- Immediately after microplastic spiking in soil and after two months of soil-microplastic incubation
- Statistical tools (ANOVA and Mann-Whitney U test) were used for result comparison

Figure 1. Soil and microplastic (< 3 mm) samples before mixture preparation. Plants grown in soil with added microplastic and determination of plant shoot fresh weight after 13 d growth. Photos: Liisa Maunuksela, Finnish Food Authority

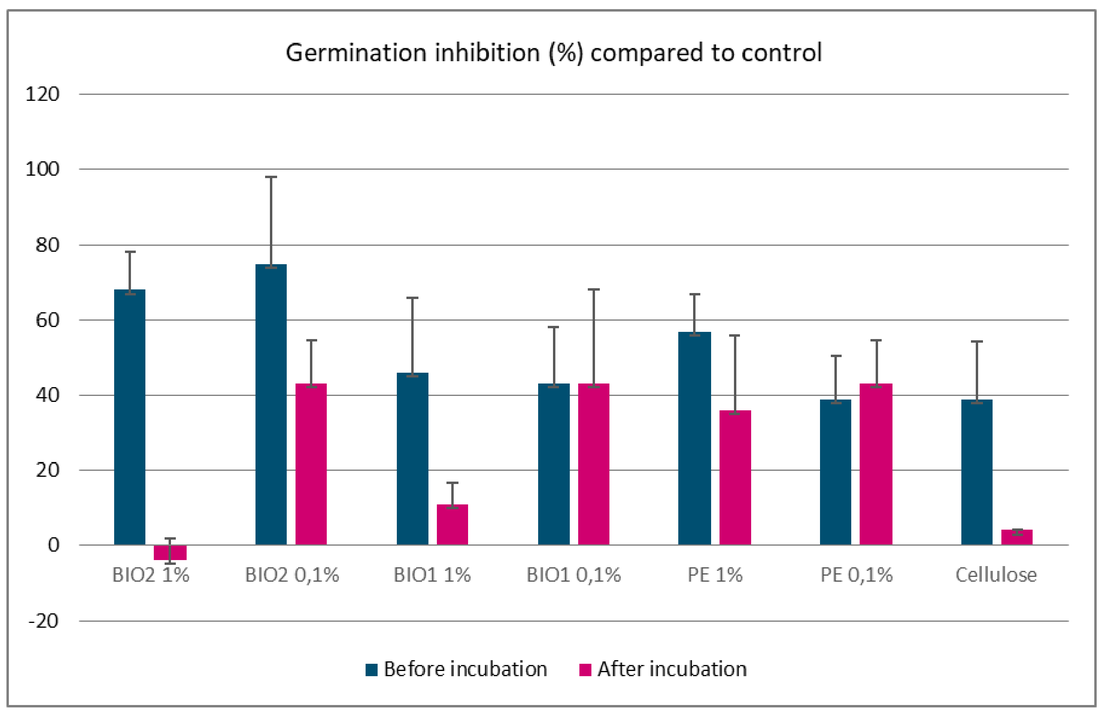
Results and Conclusions

Plant germination

- In recently spiked soils, germination was negatively affected (39-75%) in all plastic treatments when compared to untreated control
- After incubation, lowered germination was detected in soils containing 0.1% and 1% PE, 0.1% BIO1 and 0.1% BIO2

Plant growth

- In incubated soil-plastic mixtures, all plastic treatments increased plant growth by 24-115% with most prominent growth increase (over 100%) in soils treated with biodegradable plastics (1% BIO1 treatment and both concentrations of BIO2), though the differences to the control treatment were not statistically significant due to the variation between the three replicates
- In recently spiked plastic treatment, the highest increase in growth (32%), was detected in 1% BIO2, whilst in cellulose treated soil growth of plants was decreased by 32% when compared to control. The only significant difference in plant growth was between these two treatments, whilst no significant difference to control was found
- Results showed a clear physiological response of plant germination and growth rates to microplastic addition
- Further studies from this project, including results from soil microbiome, soil earthworm, nutrient and physical properties, will aid in assessing the cause for plant response and overall potential risks and benefits of mulching film materials



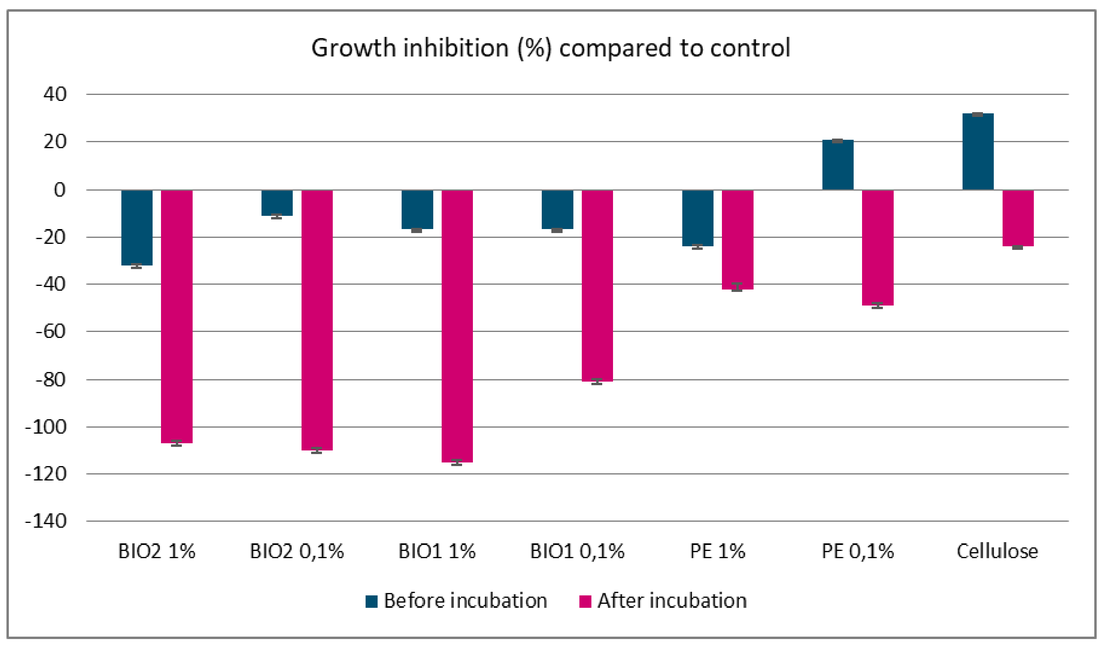


Figure 2. Plant response to microplastics in concentrations of 0.1% and 1% (w/w) shown as effect on plant growth and seed germination (%, Mean ± SE). Results of two exposures are shown: one in freshly spiked soil (blue bars) and another in soils that had been incubated for two months after addition of plastic particles (red bars). BIO1 and BIO2 = two different types of biodegradable plastics, PE = polyethylene plastic.

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This study is part of "Microplastics in agricultural soil – Sources, effects and reduction (MicrAgri)", a project funded by the Ministry of Agriculture and Forestry of Finland, Makera Fund.