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Contaminants Release by Biodegradable and Conventional Mulching Films into Agricultural Soils and Crops

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Extended Abstract

Mulching is a widely practiced agricultural technique employed to enhance the quality of crops and harvests [1]. Typically, mulching films are made of polyethylene. The polyethylene used in mulching contains additives, such as phthalates, which are known to disrupt several endocrine functions [2]. Plastic mulching can pose both physical and chemical hazards to human health and the terrestrial environment, as pollutants carried by these films can enter food chains through soil organisms and crop plants.

In response to these challenges, biodegradable plastic mulches have been produced as an alternative. Due to their biodegradable nature, they can be left in the fields. This would lead to a reduction in plastic waste and alleviate the costs associated with collection, treatment, and disposal. Despite these advantages, concerns arise regarding the potential release of substances from biodegradable mulches, raising questions about their impact on biodiversity and human health.

To assess the impact of mulches on contaminant transport, we analyzed soil and crop plants exposed to different mulching materials. A small-scale field experiment was conducted to replicate realistic mulch usage conditions where strawberry plants were cultivated using four different types of mulches: polyethylene (PE), oxo degradable PE (PE-OXO), polypropylene (PP), and polybutylene adipate terephthalate (PBAT)/starch. Soil, strawberry, and mulching film samples were analyzed by GC-MS for phthalates and other plastic additives such as acetyl tributyl citrate, di-n-butyl sebacate, and tris(2-ethylhexyl) phosphate.

The Kruskal-Wallis test showed significant differences in the total concentration of phthalates between the control soil and soil mulched with PE-OXO ($p=0.033$) and PP ($p=0.002$). Furthermore, a significant difference was observed between the soil mulched with PE and that mulched with PP ($p=0.048$). However, no statistically significant differences were found between the control and the soil mulched with PBAT-starch and PE ($p=1$). Regarding dibutyl sebacate and acetyl tributyl citrate, the statistical tests did not show any significant differences among the treatments ($p>0.143$).

Statistical tests on mulching film samples revealed significant differences in total phthalate concentration between PBAT and PE-OXO mulches ($p=0.0194$). Specifically, the variations were statistically significant when comparing the concentrations of dibutyl phthalate and bis(2-ethylhexyl) phthalate ($p=0.0134$ for both). Significant differences were also observed between PBAT and PP mulching films ($p=0.028$) regarding dimethyl phthalate, and between PE and PBAT mulches concerning dibutyl phthalate ($p=0.0134$). Benzyl butyl phthalate was exclusively detected in PP mulches.

Regarding the other additives, the concentration of acetyl tributyl citrate in PBAT mulches was significantly higher than in PE-OXO mulching films ($p=0.0279$). Dibutyl sebacate was detected in all samples except PE mulches, yet no significant differences were found among the other three different materials ($p=0.066$).

Data from strawberry samples are currently being analyzed and will be presented at the conference. Our results will determine whether biodegradable and non-biodegradable mulches pose risks to agricultural soils and whether there are significant differences between them in terms of contaminant transport.

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