

Do Microplastic Residuals in Municipal Compost Bioaccumulate in Plant Tissue?



Marine Plastic Pollution



What about Plastic Contamination in Soil?



Research Questions

Do microplastics exist in municipal industrially-produced compost?

Do microplastic residuals present in municipal compost bioaccumulate in plant tissue?



Photo Credit: J. Paul Transform Compost Systems

Plastics in Soil

- Plastic debris accumulating in the natural environment at a rapidly increasing rate due to its limited recovery process and durability.
- Issues with bio-based and 'compostable plastics' increasingly entering the market and into municipal compost streams.
- Virtually impossible to distinguish compostable plastics from conventional plastic at a glance.
- Compostable plastics do not always perform as designed or certified in regional composting facilities due to the discrepancy between actual processing timelines and laboratory-tested certification timelines.
- Average aperture for screening out plastics and contaminants is 8mm-15mm...microplastics are defined as <5mm.
- Growing recognition that microplastics (from conventional and biobased plastic) can be introduced into the soil through industrially processed compost applied to agricultural land.

Research Overview



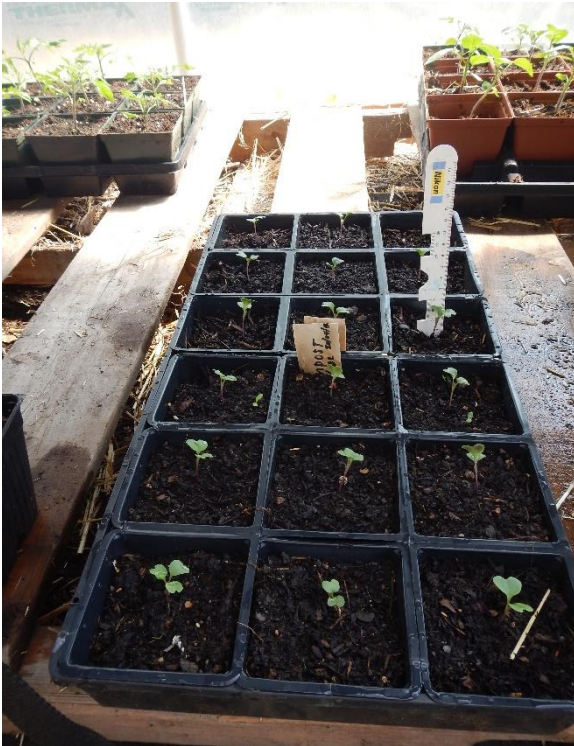
- Research explored whether microplastic residuals present in industrially produced compost bioaccumulate in plant tissue grown in this medium.
- Experimental design modeled on methodologies used in aquatic research of microplastics in bivalves to determine whether these marine research methodologies can be adapted for terrestrial applications.

Research Design and Methodology

- Quantitative data analysis using a mixed methodology approach to exploratory research based on microplastics research in the marine environment.
- Two 1m² plots, one filled with industrially-produced municipal compost known to contain plastic residuals, the 2nd plot filled with a control compost with an absence of plastic residuals.
- Both plots seeded with Pilgrim's cabbage (*Brassica oleracea*); growing period before sampling was 25 weeks.
- Plant tissue assessed for microplastics occurrence and toxicity.
- Histological examination of plant stalk tissue using hematoxylin and eosin stain.



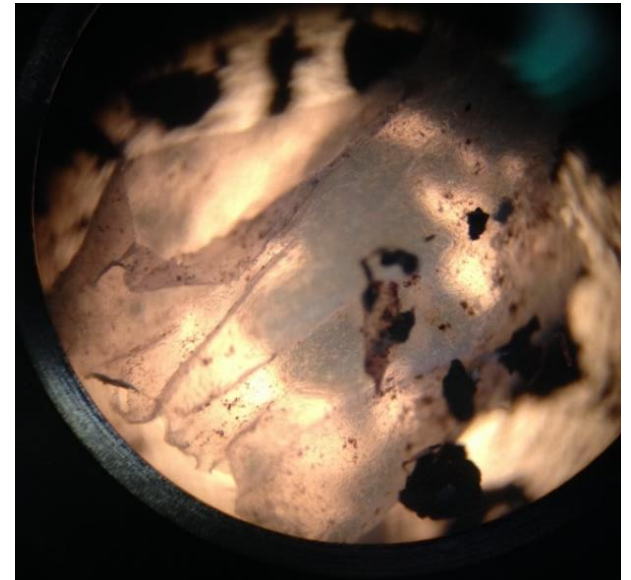
Supplementary Tests



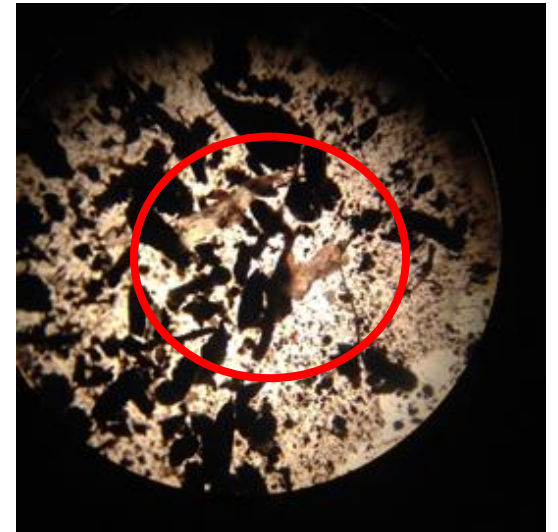
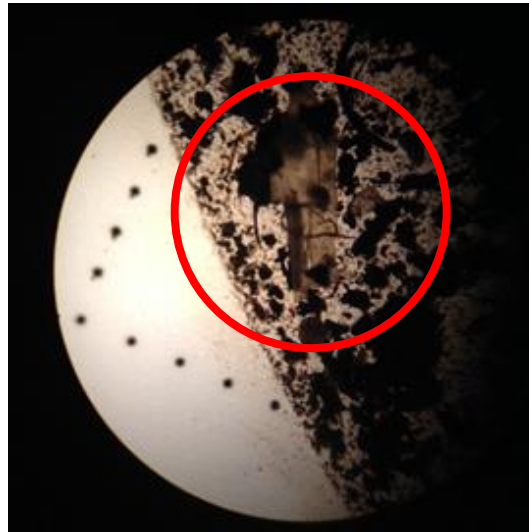
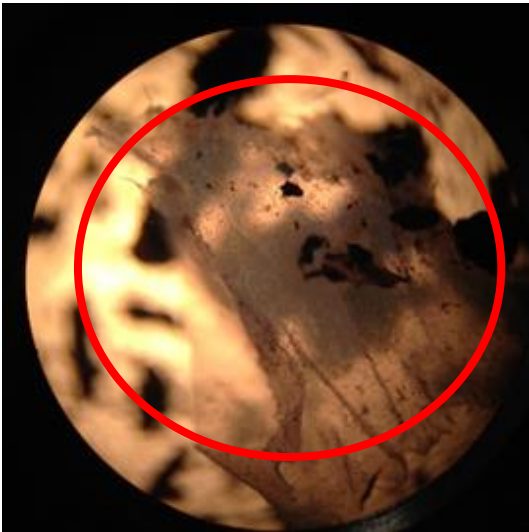
- Phytotoxicity sample testing and analysis of seedlings (germination rate, growth).
- Heavy metal analysis (e.g., oxo-degradable plastic found to contain metal salts).

Results of Study

- No plastic fragments were observed in the control compost samples through manual extraction.
- Large volume of plastic particles were observed in the test compost samples (0.5mm – 34mm in size)
- Further results from a saline flotation test indicated the presence of plastic fragments in the test compost samples (0.1mm - 3.9mm in size)
- 100% of the seeds planted in the control compost germinated and 89% germinated in the test compost
- Both compost samples were below the limit of detection (LOD) for heavy metals for the Canadian Council of Ministers of the Environment (CCME) soil quality guideline (SQG) for agricultural land use.

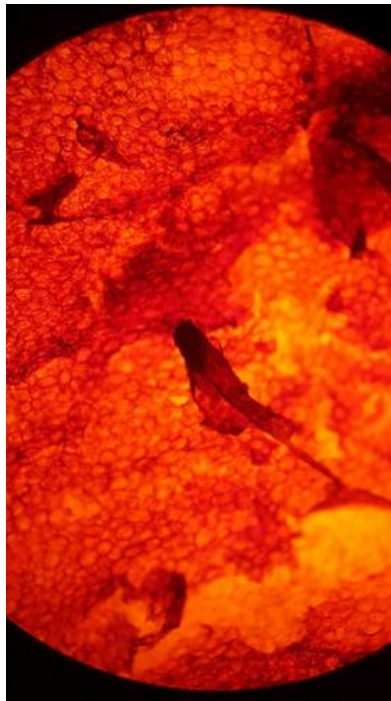


Results Continued



Industrial compost samples: *plastic fragments observed after saline flotation test extraction under bright light microscopy at 10x magnification.*

Microplastics Detected in Plant Tissue



- Histological examination revealed the presence of suspected microplastics in 57% of the tissue samples grown in the test compost.
- Only one suspected microplastic particle detected in tissue samples grown in the control compost.
- Tissue staining with H & E was optimal with thinner sections of plant samples (1mm).

Possible Pathways for Bioaccumulation

1) Travel in suspension through root rhizosphere

- Originally hypothesized that mechanical transport of microplastic particles may be plausible based on the particle density of the suspected microplastic particles relative to that of minerals that plants regularly uptake.
- Given that examples of microplastics have been found in the aquatic environment that are smaller or comparative with certain elements and trace minerals.

2) Adherence to outer plant tissue ('bark' enveloped over the colder winter)

- Higher likelihood pathway for the observed microplastics in the plant tissue in this study was a result of particles adhering to the outer stalk of the plant, allowing the outer fibrous tissue to grow around and encase it.

Research Conclusion

- Occurrence of microplastics in the natural environment is increasing and microplastics contamination research has focused on the aquatic environment with less research existing on terrestrial effects.
- The presence of suspected microplastics found in this research was observed in nearly 60% of the plant tissue sections grown in the industrially produced compost as compared to less than one percent in the control compost.
- Further research into the rate of accumulation and potential toxicological effects of microplastics in soil ecosystems needs to be conducted to establish the extent of microplastics contamination and level of concern for ecotoxicity in terrestrial ecosystems.

Government Policies to Address Plastics in the Environment

Province of British Columbia Proposed *Waste Prevention Regulation**

- Ban on plastic checkout bags & fees on paper and reusable bags.
- Ban on plastic straws (with accessibility exemptions).
- Ban on polystyrene foam service ware (cup, plate, bowl, tray, carton or lidded container).
- Ban on compostable plastic foodservice ware.**
- Ban on plastic cutlery.

Federal Environment Canada *Single-use Plastics Prohibition Regulations**

- Added plastic manufactured items as a toxic substance to the Canadian Environmental Protection Act (CEPA) in April 2021.
- Bans on plastic check-out bags, cutlery, stir sticks, and straws.
- Ban on expanded polystyrene, extruded polystyrene, polyvinylchloride (PVC), oxo-degradable plastic, carbon black pigment.
- Exemptions: all other plastic foodservice ware (PET, PP, HDPE, PLA, rigid PS).

*compostable and biodegradable plastic is included under the definition of plastic.

**compostable plastic is not accepted under the Organic Matter Recycling Regulation



Local Government Action

City of Victoria proposed *Single-Use Items Reduction Bylaw* for the protection of the natural environment will require businesses to:

- Distribute single-use straws, utensils, stir sticks, and condiment packages (made of any material) only when requested.
- Use reusable products for food and beverages consumed on the premises of the business.
- Charge a \$0.25 fee for any single-use takeout cup or container to encourage reuse.





Thank You!

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