

CASE STUDY

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Microplastics and land application of biosolids: Insights from Southern Ontario studies

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About this brief

This brief synthesizes key findings from a series of studies led by Dr. Ryan Prosser at the University of Guelph on microplastics in Ontario biosolids, agricultural soils, and earthworms. Although it is not a comprehensive review of all available research on this topic, it incorporates relevant supporting literature to contextualize these findings and assess their implications for municipal biosolids management in Ontario.

Key insights

- **Microplastics are widespread in agricultural soils.** They enter the environment through multiple pathways, including atmospheric deposition, road dust, synthetic textiles, plastic-coated fertilizers, and other human activities. As a result, microplastics are commonly found in soils even in the absence of biosolids application.
- **Biosolids are one of several sources of microplastics in soil.** Dr. Prosser's research detected microplastics in all agricultural soils studied, including fields with no history of biosolids application. While fields receiving biosolids generally had higher microplastic concentrations, biosolids were not the sole determinant of microplastic levels in soil.
- **Biosolids application was associated with higher microplastic concentrations, but the magnitude of the increase varied.** This suggests that biosolids contribute to, but do not exclusively determine, microplastic levels in agricultural soils.
- **No adverse effects on earthworms were observed at current microplastic concentrations.** Dr. Prosser's research found no evidence that current microplastic concentrations in Ontario agricultural soils harm earthworm survival, reproduction, or behaviour, suggesting current soil concentrations are not known to impair this important soil organism.
- **Important questions remain about long-term environmental impacts.** Researchers continue to investigate how microplastics accumulate and move through soils, whether concentrations are changing over time, and what long-term effects they may have on soil health and ecosystems.

What are microplastics?

Microplastics are small plastic particles less than five millimetres in size. They can be produced intentionally for use in products and industrial applications, or form when larger plastic items break down over time.¹

Microplastics are now widespread in the environment and have been detected in air, water, soil, wildlife, food and remote regions around the world, from the Arctic to the deepest parts of the ocean.² Scientists are actively studying their potential impacts on human health, animals, and ecosystems, as well as how they move and persist in the environment.³ Microplastics enter the environment through many pathways, including litter, wastewater, urban runoff, tire wear and the breakdown of plastic products.⁴

Why study microplastics in biosolids?

Municipalities across Canada apply biosolids to agricultural land, which helps recycle nutrients and organic matter. While this practice improves soil quality and supports agricultural productivity, municipalities must also understand and manage potential environmental risks associated with contaminants that might be present in biosolids.

One contaminant receiving increased attention is microplastics. This brief summarizes findings from a series of studies led by Dr. Ryan Prosser at the University of Guelph, funded by the Natural Sciences and Engineering Research Council of Canada's (NSERC) Plastics Science for a Cleaner Future grant. The research measured microplastic concentrations in biosolids produced by wastewater treatment plants in Ontario, compared soil microplastic levels in fields with and without a history of

biosolids application, and assessed potential impacts on earthworms.

Research focus

Three aspects of Dr. Prosser's research are particularly relevant to municipalities:

1. The presence of microplastics in Ontario biosolids.
2. The relationship between biosolids application and microplastic levels in agricultural soil.
3. Potential effects of microplastics on earthworms, an important indicator of soil health.

To investigate these topics, researchers analyzed biosolids from 11 wastewater treatment plants across Southern Ontario. They examined the main types of biosolids produced and land-applied in Ontario: liquid, dewatered, pelletized, and alkali-stabilized biosolids. Researchers also collected soil samples from 20 agricultural fields, including eleven fields with and nine without a history of biosolids application.

Finally, the team conducted laboratory studies to evaluate whether exposure to microplastics affected earthworm survival, reproduction, and behaviour.

Why are microplastics found in biosolids?

Microplastics enter wastewater treatment plants (WWTPs) from households, businesses, industry, stormwater, and other sources. Wastewater treatment processes capture most of these particles, with studies reporting removal rates typically exceeding 88 percent and often reaching 94 to 99 percent.⁵ Rather than being eliminated, many of the captured particles accumulate in sewage sludge, becoming concentrated in biosolids. As a result, biosolids contain microplastics that can be introduced to agricultural soils when biosolids are land applied.⁶



What microplastics are found in biosolids?

Researchers found microplastics in every biosolids sample they tested. On average, biosolids contained about 372,000 microplastic particles per kilogram of dry material, though concentrations varied by facility and treatment process. These findings show that wastewater treatment plants capture and concentrate microplastics in the solids removed during treatment.

The most common microplastics in biosolids were plastic fragments or fibres. Researchers identified several different types of plastic, with polyester and polyethylene occurring most frequently. The large number of polyester fibres suggests that synthetic clothing is an important source of microplastics entering wastewater systems.

The study also found that alkali-stabilized biosolids contained lower microplastic concentrations than other biosolid types from the same wastewater treatment plants. Concentrations were approximately 37 percent to 61 percent lower. Researchers hypothesize this may be due to dilution from the alkaline materials added during stabilization, although more research is needed to understand why.

Overall, the research shows that microplastics are present in biosolids produced in Ontario.⁶

How biosolids affect microplastic levels in agricultural soils

Dr. Prosser's team compared soil samples from 20 agricultural fields in southern Ontario. Eleven fields had a history of biosolids application, while nine never received biosolids.

Researchers found microplastics in every field sampled. However, fields with a history of biosolid application generally contained higher microplastic concentrations. On average, biosolids-amended fields contained about 2,442 microplastic particles per kilogram of dry soil, compared with about 775 particles per kilogram in fields without a history of biosolids application.

These findings suggest that applying biosolids can increase microplastic levels in agricultural soils. However, microplastic concentrations in soil were much lower than those measured in biosolids. This is likely due to dilution of microplastic concentration in the soil.⁴

Importantly, the team also found microplastics in fields that had never received biosolids. This shows that agricultural soils receive microplastics from many sources, including airborne deposition, road dust, synthetic textiles, plastic-coated fertilizers, and other human activities.^{7,8}

While biosolids contribute microplastics to agricultural soils, they are only one of several sources.⁴

What the research found about earthworms and soil health

Earthworms play an important role in maintaining healthy soils. To understand whether microplastics could affect soil organisms, Dr. Prosser's team studied earthworm survival, reproduction, and behaviour in laboratory experiments.

Researchers exposed earthworms to four common types of microplastics at concentrations ranging from 1,000 to 1,000,000 particles per kilogram of soil. These concentrations included levels far higher than those typically found in Ontario agricultural fields.

Overall, researchers found no consistent evidence that microplastics affected earthworm behaviour, survival, or reproduction. Earthworms did not avoid soils containing microplastics, and survival rates remained high across all treatments. Reproduction was also similar between microplastic-treated soils and uncontaminated control soils.

These findings are notable because the experiments tested concentrations well above those currently reported in Ontario agricultural fields.⁹

Based on this research, microplastic concentrations currently found in Ontario agricultural soils are not known to adversely affect earthworm health or behaviour.

Remaining questions and research needs

Dr. Prosser's research has improved our understanding of microplastics in biosolids and agricultural soils, but important questions remain.

Further study is needed to clarify whether microplastic concentrations in soils are changing over time as global plastic production increases. They also need to further explore what happens to microplastics after land application, including whether particles remain in the soil, move through drainage systems, or are transported to nearby water bodies through runoff.

Another area of ongoing research is whether crops can take up microplastics from soil. Answering this question is challenging and will take some time because very small plastic particles can be difficult to detect and measure accurately.

Researchers are also studying how microplastics may affect a broader range of soil organisms and ecological processes.

Continued monitoring and research will help municipalities better understand the long-term behaviour and potential impacts of microplastics in agricultural systems.



What these findings mean for biosolids management

Dr. Prosser's recent studies show that microplastics are commonly present in biosolids and that land application can increase microplastic concentration in agricultural soils.

However, the team also found microplastics in every field studied, including fields with no history of biosolids application. This indicates that agricultural soils receive microplastics from many sources, not just biosolids.

The studies found no evidence that microplastic concentrations currently observed in Ontario agricultural soils negatively affect earthworm survival, reproduction, or behaviour. At the same time, important questions remain about how microplastics move through the environment and how concentrations may change in the future.

For municipalities, these findings provide important context for understanding the role of biosolids as one contributor to environmental microplastics. Continued monitoring and research will help support evidence-based decisions about biosolids management and beneficial use programs.

Staying informed about emerging science, monitoring approaches, and potential policy developments will help municipalities support evidence-based decision-making and the continued beneficial use of biosolids.

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