

I BET YOU DIDN'T KNOW...

Plastics in soil affect the survival of plants and worms

Dr Katharine Pemberton, PSTT College Fellow, links cutting-edge research with the principles of primary science



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For a few years, scientists have known that *pollution* of the oceans by *microplastics* is harmful to animals and plants living in the sea. We know that our soils are polluted with microplastics too. Scientists at Anglia Ruskin University have investigated how these plastics affect plants and animals living in the soil.

Figure 1. Several species of earthworms are found throughout the world; and many are important in the process of soil formation.



Earthworms (Figure 1) and other animals are important to soil because when they burrow in it and feed on it, they help to create its structure. When the worms eat *organic matter* in the soil, they break it down, releasing *nutrients* and *minerals* into the soil that plants need to *photosynthesise* and grow. Organic matter is any material produced by a living organism such as leaves and other parts of plants or dead animals.

What are microplastics and where do they come from?

In agricultural land, land used for farming, there are thought to be between 700 and 4,000 plastic *particles* per kilogram of soil. One teaspoon contains about 5g of soil, so you would expect there to be between 3.5 and 20 plastic particles in every teaspoon of soil. Plastics in the soil comes from plastic particles in rainwater; from

particles floating in the air; from water used to water plants and from sewage used as fertilizer. Plastic is also used on farmland to cover the soil so that weeds are limited and only the crop grows. This is called plastic mulching and is another source of plastic in soil, even though the plastic is often *biodegradable* – that means it can break down in the soil. Microplastics are plastic particles that are less than 5mm in diameter. There are many different types of plastic including *polythene*, *nylon* and *acrylic*. Polythene is not biodegradable and can remain in the environment for decades. Nylon and acrylic fibres come from our clothing and are washed into the sewage system from washing machines. Some biodegradable plastics are now being used but it takes a very long time for them to break down.

How did the scientists investigate what happens to microplastics in soil?

In this study, scientists studied the effects of microplastic contamination on the rosy-tipped earthworm (*Aporrectodea rosea*) and a type of ryegrass that is very common in grasslands of northern Europe (perennial ryegrass: *Lolium perenne*) (Figure 2).

Figure 2. Perennial ryegrass is a low growing, tufted grass. It is used for grazing livestock, for hardwearing lawns, and for preventing erosion.



Three different types of microplastics were used in the investigation: nylon and acrylic fibres from clothing; micro-particles of polythene and micro-particles of a biodegradable plastic used in farming. The experiments were carried out in 1.3 litre plant pots and each test pot contained soil, earthworms and a different type of microplastic. The control pots contained no microplastics. There were eight different combinations of microplastics and plants and each was called a 'treatment' (Figure 3). Some pots had ryegrass planted in them and some did not. This was to see if the presence of the grass affected the growth of the worms. Each treatment was replicated five times.

To set up the investigation, the microplastics were mixed with the soil and both were added to the pots. All the pots were watered and 24h later, two earthworms were added. Each worm was weighed before it was put in the soil. Rye grass was then added to the pots that needed it: 200 seeds were sown in each pot. The pots were watered every day for 30 days.

At the end of the investigation, the scientists measured a range of features of the plants:

- how many seeds had germinated in each pot
- their total mass of shoots and roots
- how moist they were
- their *chlorophyll* content

Chlorophyll is the chemical that plants produce to allow them to make their own food by *photosynthesis*. If they have no chlorophyll, plants cannot photosynthesise and will die. When plants are under stress, they may produce different amounts or different types of chlorophyll.

The scientists also measured the mass of the worms and some features of the soil:

- the pH (how acidic it was)
- how much organic matter there was
- how moist it was
- how it stuck together to form clumps called 'aggregates'

How did microplastics affect plants?

The scientists found that the results depended on the type of plastic used. Polythene had no effect on seed germination, but clothing fibres and biodegradable plastics led to a decrease in germination. The plants' shoots were shorter when the pots contained biodegradable plastic, but the overall mass of shoots was not affected, so they must have grown more, shorter shoots. The plants had 45% more roots when they were grown with polythene particles compared to those exposed to biodegradable plastics. The chlorophyll content of all the plants grown with microplastics was affected. The total amount of chlorophyll did not change but the ratio of the different types of chlorophyll in the plants was very different compared to the control.

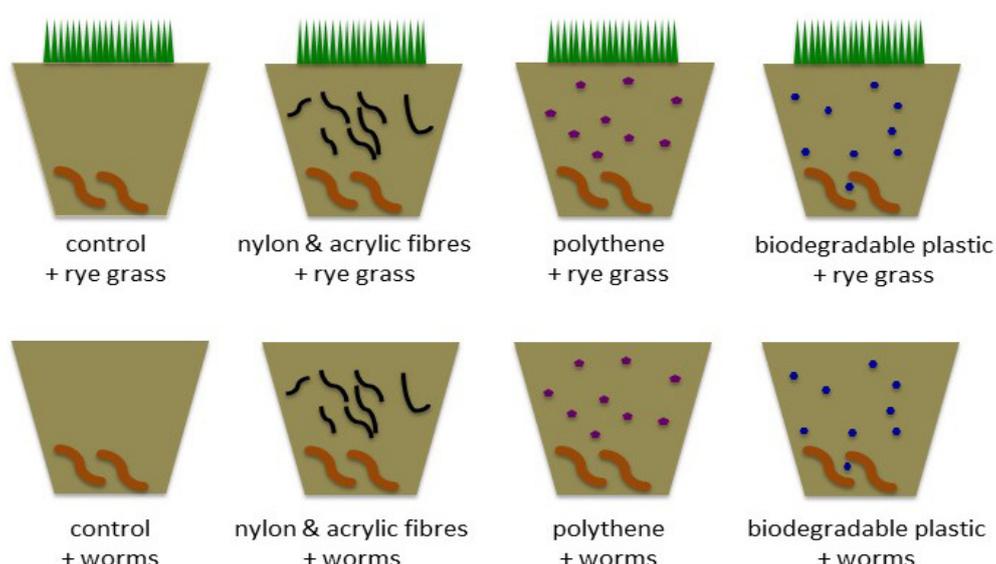
How did microplastics affect earthworms?

All the worms survived but those that were in the pots containing microplastics had lost weight whilst all the worms in the control pots had gained weight. The results were the same with or without the rye grass in the pots.

How did microplastics affect soil?

The plastics had also affected the soil itself. The soil pH had changed but the type of change varied and the soil in pots containing polythene became more acidic than other pots.

Figure 3. Diagram showing the 8 treatments set up by the scientists.



What did the scientists conclude?

The scientists concluded that different types of plastics had different effects on the plants. This may be due to the different shapes of the microplastics or may be because they contain different compounds and some compounds are more *toxic* to plants than others.

To get enough nutrients, worms must eat large amounts of soil and it is possible that the plastics damaged their digestion system, stopping them from getting the nutrients they needed to grow. This could ultimately lead to their death.

If soil becomes more acidic, the *microbes* that breakdown organic matter in it may be damaged and minerals may not get recycled for new plant growth.

Why is this work important?

These results are important for farms and gardens because the quality and quantity of crop plants depends on the quality of the soil. Even though the scientists do not know why the plants and worms were affected, the study did show that plant growth was changed by microplastics. Because of their important role in processing the soil, earthworms can affect plant growth too so any damage to them may lead to a decrease in plant growth in the long term. There is also the possibility that microplastics could be incorporated into plants as they grow, and this could pose a threat to animals that eat those plants. The amount of plastics could build up in any animal eating lots of plants. This is called *bioaccumulation* and could ultimately lead to humans ingesting plastic from plants.

Questions for children to consider:

- What plants do you eat?
- What might happen if these plants contain microplastics?

Practical activities and investigations that enable children to mirror the research of the scientists are described in the accompanying [Teacher Guide](#).

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The paper that inspired this article was:

Effects of microplastics in soil ecosystems: above and below ground.

By Bas Boots, Connor William Russell and Dannielle Senga Green.

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GLOSSARY

acrylic

a type of plastic

bioaccumulation

the gradual accumulation of substances in an animal or plant

biodegradable

able to be broken down in nature by microbes (which prevents pollution)

chlorophyll

the chemical that plants use to trap energy from sunlight, to use in photosynthesis

microbes

microorganisms such as bacteria

microplastics

plastic particles that are less than 5mm in diameter

minerals

substances required by plants and animals in tiny amounts for various functions, for example calcium and copper

nutrients

a substance that plants and animals need to survive, for example carbohydrates and proteins

nylon

a type of plastic

organic matter

any material produced by a living plant or animal, such as leaves or dead animals

particles

very small pieces

photosynthesis

the process where plants use energy from the sun, with water and carbon dioxide, to create their own carbohydrate or food

photosynthesise

when a plant produces its own ‘food’ by photosynthesis

pollution

the presence or introduction of a substance to the environment which has harmful effects

polythene

a type of plastic

toxic

poisonous