Earthworms Transport Agents of Micro-Plastic in Soil

Abstract

Earthworm activity results in vermicomposting, ~~which is~~ rich in vitamins, growth hormones, proteases, amylases, lipases, cellulose, chitinase, and immobilized microflora and macro and micronutrients. After the enzymes are expelled from the worms, they still break down organic materials. The benefits of using vermicomposting in agricultural production include decreased water use for irrigation, reduced pest and termite attacks, decreased weed growth, faster seed germination and rapid seedling growth and development, more fruits per plant (in vegetable crops), and more seeds produced annually (in cereal crops). Without using agrochemicals, vermicomposting and earthworms can increase horticulture output. Vermicomposting has advantages, although its application is still relatively new. This review aims to raise awareness about this particular local soil amendment.

Key word: Earthworms, Micro plastics,Soil.

Introduction

Plastics are becoming a commonplace material in many industrial sectors, including building. Since 1950, plastics have become a major issue, medical care, agriculture, and plastic manufacture have all increased yearly. As a result, studies and worries about environmental issues brought on by plastic garbage are growing. Polystyrene (PS), polyethylene (PE), and polyethylene tere phthalate (PET) are three examples of the many kinds of plastics. The majority of research on microplastics has been conducted on how plastic and microplastic affect earthworms, or the soil biota.

Plastic has no doubt altered our daily life as a cheap, durable, and adaptable material for an enormous range of things. Plastic has ~~obviously~~ been beneficial to civilization, but it has also become a major environmental concern. However, microplastics are anticipated to become surface-level contaminants regardless of where they originate. There is an urgent need for study on how to incorporate this material into the soil profile. Even while using plastic has many positive effects overall, the buildup of plastic debris in the environment, particularly microplastic, is becoming a bigger environmental worry. The soil biota should only be widely exposed to these particles once this substance has been incorporated into the soil.

Earthworms are essential to the soil ecology because they break down organic materials and preserve soil structure. According to several research, earthworms cannot thrive in soil that contains particular concentrations of microplastics. Composting and the managing solid waste, particularly organic waste like food scraps and agricultural waste, are two common applications for earthworms. However, earthworms are not as useful in the decomposition of plastic or microplastics. The earthworms Eisenia Andrei, Esenia Foetida, and Lmbricus terrestris are most frequently utilized in decomposing of plastic and microplastics. Here, we investigated the possibility that earthworm activity may carry surface-deposited microplastic particles of various sizes. Huerta Lwanga et al. have previously demonstrated that *Lumbricus terrestris* Lmight really introduce tiny pieces of plastic into burrows. Here, we investigate the hypothesis that tiny plastic particles exist. Could be carried by earthworms from the soil's surface lower into the soil profile.

Materials & methods

- For a total of 10 pots, we conducted a completely factorial experiment in which the presence or absence of earthworms was coupled with each additional PE-microplastic size.
- Additionally, to determine any impacts on earthworms, a control group was included that did not include microplastics.
- The temperature of the air-conditioned greenhouse used for this 21-day experiment was 35 °C.
- To prevent standing water and earthworm escape during the experiment, we utilized plant pots (volume: 3 L; height: 19.2 cm; diameter: 17.0 cm) as containers (experimental units). The bottom of the pots was covered with permeable black fleece.
- • Although this type of earthworm can dig tunnels down to a depth of more than 0.3 meters, the purpose of this arrangement was to clearly show

how particles travel rather than to determine the greatest depth to which they may transport particles.

- 5.0 g of dried Populus spp. were added to each container along with 5 kg of soil.
- • To ensure that the earthworms have access to enough organic matter, add chopped leaf litter—a substance that is good for these earthworms—to the soil's surface.
- • Although we did not track the amount of water in the soil, we did water all of the pots with 250 mL of water every two days at the same time (beginning 10 days before the addition of earthworms), since this was determined to be appropriate in preliminary testing.
- • Throughout the research, pots could freely drain. At the start of the experiment, 750 mg of the variously sized PE-microplastic particles were put to the soil surface by weight.
- • In early testing, this quantity of microplastic did not directly harm earthworms.For the different sizes this translated to:

1. 650 particles (PE-1) 2. 100 particles (PE-2)

3. 50 particles (PE-3) 4. 20 particles(PE-4)

Result

- The transportation of microplastic particles away from the soil surface was greatly enhanced by the presence of earthworms, and the impact of microplastic size on this effect was shown to be significantly different (P=0.03).
- Additionally, the distribution of microplastics at various soil levels was found to be significantly impacted by the presence of earthworms and particle size.
- Microplastic particles remained in the top soil layer in the absence of earthworms, but throughout the 21-day experiment, microplastic particles of all sizes reached the middle and bottom soil layers in the presence of earthworms. The smallest particles (PE-1) were most heavily transported into the bottom soil layer (interactive effect of earthworm

presence, particle size, and layer).

- When earthworms were present, the other three particle sizes were primarily located in the intermediate layer.
- Only the two lower size classes' casts (observations made in Petri dishes) included microplastic particles; the two larger size classes' casts did not contain any microplastic particles.
- In all microplastic size treatments involving earthworms, surface middens (observations in the pots) included microplastic particles.
- Additionally, we saw that the earthworm body was sticking to tiny plastic beads.
- There was no discernible impact of microplastic on mortality. The same was true for effects on earthworm weights, which generally decreased from an average of 4.1g ±0.02g (standard error) before to an average of 3.4g±0.3 g after the experiment, without detectable differences between pots with or without micro plastic particles.

Discussion

As one of the first studies of this kind, we demonstrated that PE microplastic particles can be transported by anecic earthworms relatively quickly into a soil profile from the surface to a depth of 10 cm. The amount of particles that are transported appears to depend on the size of the particles, with the smallest particles being found in the deepest layer. • It was expected that earthworms would play a role in the vertical transport of microplastics, so we used a controlled experiment in pots in the greenhouse with surface-added microplastic particles that could subsequently be retrieved from the experimental soils at various depths.

• The vertical transfer of particles in the field has also been linked to earthworms. Furthermore, during a 14-day mesocosm investigation, it was demonstrated that Lumbricus terrestris incorporated PE microplastic particles in its burrows.

• Although the precise mechanisms of particle transport in this and other studies are usually unknown, they are believed to involve attachment to the exterior of the earthworm (as we frequently observed PE particles adhering to the earthworms), movement with water down the burrows, casting activity, and movement by the earthworm after passage through the gut (the latter is supported by the pervasive presence in droppings)

• It has also been shown that earthworm egestate contains PE microplastic particles, which lends more credence to the ingestion/egestion process.

• Differentiating between the relative relevance of various transport systems was not a particular goal of our investigation.

- • Since earthworm transmission has been demonstrated, next research should focus on separating these various transport routes, taking into account the quantity of plastic material presents as well as the characteristics of the soil, such as texture and structure.
- • Determine the concentration-dependent integration of microplastic material into burrow walls by comparing various concentrations of PE microplastic, as opposed to sizes, as we have done. Furthermore, to capture transfer rates under more realistic settings, it will be crucial to conduct design studies under field conditions in the future.
- • Plant roots also create large amounts of biopores; earthworms are not the only members of the soil biota that do this.
- • Considering this, it may be possible to investigate the ability of additional soil biota to promote the transport of microplastics along the soil profile.
- • Other soil biota may also contribute to the movement in both the vertical and horizontal directions, in addition to biopores that produce biota.
- Such particles may be moved in soil by termites, collembola, enchytraeids, or nematodes, but probably on a lesser spatial scale than what we have seen with earthworms thus far.Larger creatures like voles, gophers, and moles could be significant. Plow work is another aspect that might play a major role in the assimilation of materials into the soil in agroeco systems, where microplastic use is probably most prevalent.
- • The movement of microplastics along the soil profile may have many effects: Since organic material decomposes more slowly at deeper soil depths where microbial populations are significantly lower, microplastic, which is already slow to disintegrate in the environment, might become even more persistent at these deeper soil profile depths.This also emphasizes the need to examine deeper soils as techniques for measuring microplastics in soil are developed. Whether microplastic contributes significantly to soil organic carbon pools at different soil depths is currently unclear.
- After passing through the soil profile, microplastic may also find its way into groundwater, where it may have unfavorable consequences like those that have been well-documented in other aquatic ecosystems.

- • When microplastics end up in the soil, they may break down even more, creating nanomaterial that could have distinct uses and present distinct environmental hazards.
- •In summary, our research demonstrated how soil animals transfer PE microplastic particles into the soil, with the tiniest particles traveling the furthest.
- • The soil biota throughout the profile will likely be exposed to microplastics given their anticipated arrival at the soil surface. This emphasizes the need to further investigate the impacts and destiny of these particles in the terrestrial environment.

Statistical Analysis:

• Based on measurements made during harvest, we divided the downward flow of microplastic particles into two halves.

(a) The removal of anything from the soil's surface.

(b) The soil profile's vertical distribution of these transported particles.

- To examine the effects of earthworm presence, microplastic particle size, and their interaction on the relative fraction of particles retrieved from the pots' surfaces ~~at~~ after the experiment, we used a linear model for the first component.

Conclusion

In summary, our research demonstrated how soil animals transfer PE microplastic particles into the soil, with the tiniest particles traveling the furthest. The soil biota throughout the profile will likely be exposed to microplastics given their anticipated arrival at the soil surface. This emphasizes the need to further investigate the impacts and destiny of these particles in the terrestrial environment.

Reference

Adhikary, S. (2022) vermicomposting, the story of organic gold: A review. – *Agricultural Sciences,* 3:905–917.

Anonymous. (2023) earthworms'vermicomposting: A powerful crop nutrient over the conventional compost and protective soil conditioner against the destructive chemical fertilizers for food safety and security. – *Am-Euras. J. Agric. and Environ. Sci.,* 5(S):01–55.

Barik, T., Gulati, J.M.L., Garnayak, L.M., Bastia, D.K. (2022)production of vermicompost from agricultural wastes. – *Agric. Reviews*, 31(3):172–183.

Garg, V.K., Gupta, R. (2021) vermicomposting of agro-industrial processing waste. In: Biotechnology for Agro-Industrial Residues Utilisation. – Springer, Dordrecht, 431–456.

Joshi, R., Singh, J., Vig, A.P. (2020) vermicompost as an effective organic fertilizer and biocontrol agent: effect on growth, yield and quality of plants. – *Reviews in Environmental Science and Bio/Technology,* 14(1):137–159.

Seethalakshmi, S. (2020). response of eggplant (*Solanum melongena* L.) to integrated nutrient management amended soil. – *International Journal of Scientific and Engineering Research*, 2(8):1–8.

Sinha, R.K. (2023) Organic farming by vermiculture: producing chemical-free, nutritive and health protective food for the society. – Vestnik Tomskogo Gosudarstvennogo Universiteta. Biologija, 4(20):55–67.

Sinha, R.K., Soni, B.K., Agarwal, S., Shankar, B., Hahn, G. (2018). vermiculture for organic horticulture: producing chemical-free, nutritive and health protective foods by earthworms. – *Agricultural Science,* 1(1):17–44.

Sinha, R.K., Patel, U., Soni, B.K., Li., Z. (2014)earthworms for safe and useful management of solid wastes and wastewaters, remediation of contaminated soils and restoration of soil fertility, promotion of organic farming and mitigation of global warming: A review. – *Journal of Environment and Waste Management,* 1(1):011–025.

Cole, M., Lindeque, P., Halsband, C. & Galloway, T. S. (2019) microplastics as contaminants in the marine environment: *A review. Mar. Pollut. Bull.* 62, 2588-2597.

Ivar do Sul, J. A. & Costa, M. F. (2018) the present and future of microplastic pollution in the marine environment. Environ. *Pollut.* 185, 352-364.

Li, W. C., Tse, H. F. &Fok, L. (2016) plastic waste in the marine environment: A review of sources, occurrence and effects. *Sci. Total Environ*. : 333-349.

Browne, M. A. (2018) accumulation of Microplastic on Shorelines Woldwide: Sources and Sinks. *Environ. Sci. Technol.* 45, 9175-9179.

Rillig, M. C. (2016) microplastic in Terrestrial Ecosystems and the Soil? *Environ. Sci. Technol*. 46, 6453-6454.