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The Tiny Threat Beneath Our Feet: Microplastics in Soil

Nikita B.Gorde, Ritu S. Thakare, B.M. Kamble
Department of Soil Science, Post Graduate Institute,
Mahatma Phule Krishi Vidyapeeth, Rahuri
Email.id- nikitagorde88@gmail.com
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Abstract

The widespread production, continuous use, and unscientific disposal of plastic have led to significant impact on living ecosystem. Over time of degradation, larger plastic polymers degrade into smaller fragments known as microplastics (less than 5 mm). Soil serves as a natural reservoir for microplastics originating from various sources viz; sewage sludge, landfills, plastic mulch in agriculture, fertilizers, and municipal wastewater discharge environment. The accumulation of microplastics in soil impacts its physicochemical properties, disrupts the development and reproduction of fauna, affects plant growth, and alters microbial communities as well as enzyme activities also endanger to soil organisms and plant health. Some soil organisms may eventually die from ingesting microplastics. Microplastic leads to reduction in fertilizer use efficiency.

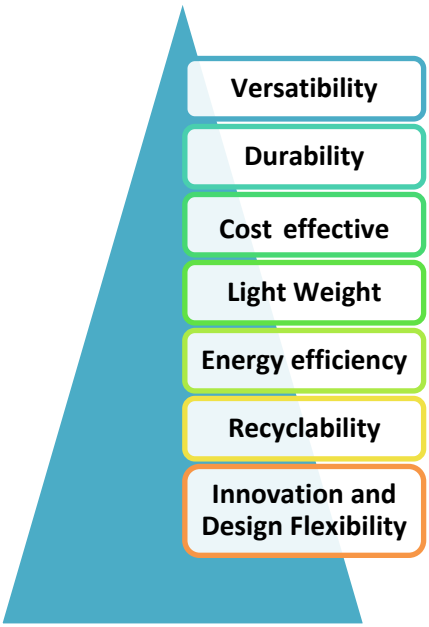
Introduction

Microplastics (MPs) are synthetic plastic particles ranging from 1 µm to 5 mm and have become a major global environmental concern. Once considered an "emerging contaminant," MPs are now recognized as a fully established threat, found in aquatic, terrestrial, and even pristine ecosystems. Their widespread presence is driven by the rising use of plastics, which has been intensified during the COVID-19 pandemic due to increased reliance on personal protective equipment. Soil, the Earth's loose top layer that supports plant growth and biodiversity, is now identified as a significant reservoir for microplastics. Approximately 80–90% of plastic waste eventually enters the soil through direct deposition, compost, sewage sludge, plastic mulches, landfill breakdown, or air deposition. The main types of MPs found in soil include polypropylene (PP), polyethylene (PE), polystyrene (PS), polyamide (PA), polyurethane (PUR), polyethylene terephthalate (PET), and polyvinyl chloride (PVC). Once in the soil, microplastics persist for long periods, impacting soil organisms, altering microbial communities, and acting as carriers of harmful pollutants. Despite growing awareness, research on MPs in terrestrial ecosystems remains limited

compared to aquatic systems. Understanding the sources, distribution, and ecological impacts of soil microplastics is therefore critical to safeguard soil health and ecosystem function.

The Rising Demand for Plastics:

According to a new report- As many as 217 countries will release 3,153,813 tones of microplastics into the world's waterways by the end of 2024.



❖ **Microplastics?**

Any plastic piece smaller than five millimeters is known as a microplastic. Plastics are presently classified based on size, as depicted in Fig 1: macro plastics (> 25 mm), mesoplastics (5–25 mm), large microplastics (1–5 mm), small microplastics (1 µm–1 mm), and nanoplastics (< 1 µm).

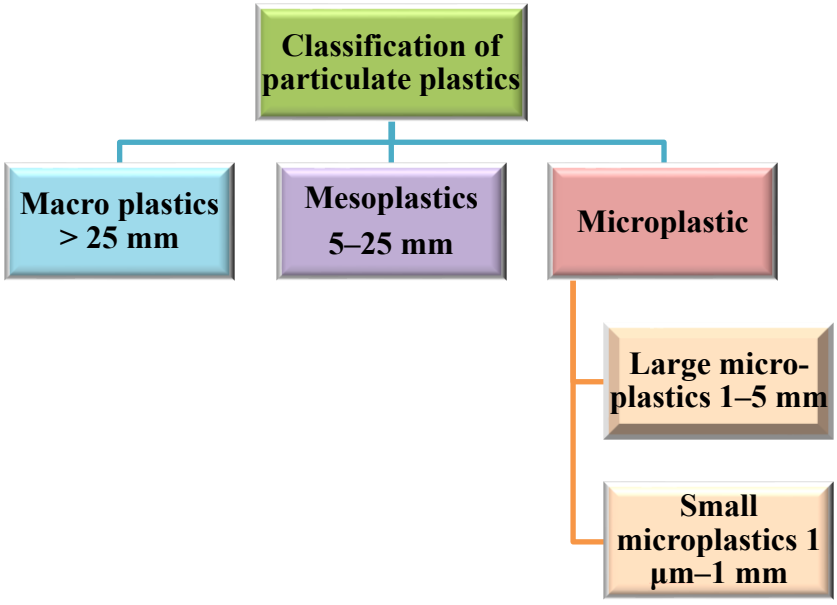


Fig 1. Illustrates the classification of particulate plastics according to their size[1,2]

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❖ **Types of Microplastic:**

Primary microplastics: These are plastic particles or fragments with an initial size of less than 5 mm before entering in the environment. Examples include microfibers, plastic pellets and microbeads.

Secondary microplastics: Secondary microplastics are plastic particles that created when the larger plastic products break down naturally through weathering after they are released into the environment. Examples include plastic bottles, fishing nets, and tire wear depicted in fig.2

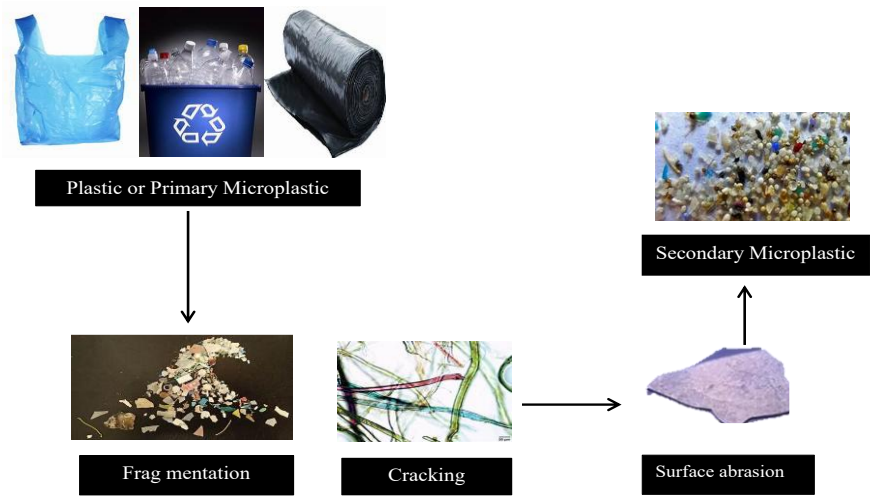

Fig 2. Formation of secondary microplastics

❖ **Sources of MPs**

Microplastics are increasingly entering farmland from everyday agricultural materials. Common sources include plastic bottles, PVC pipes, plastic bags, nursery trays, and even plastic-coated fertilizers fig 3. Additionally, agricultural films made of polyethylene (PE) and polyvinyl chloride (PVC) contribute significantly, as they degrade very slowly in soil. Over time, these plastics accumulate, disrupting soil health, affecting microbial communities, and posing a growing threat to sustainable agriculture.

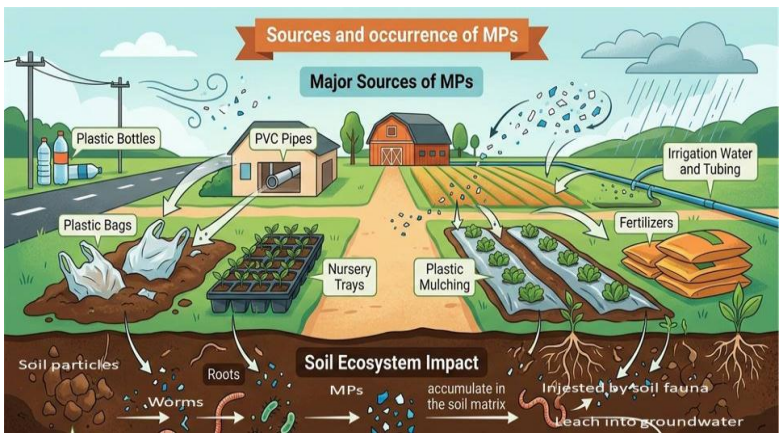

Fig.3 Sources and occurrence of MPs[2]

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EFFECTS OF MICROPLASTICS ON SOIL ECOSYSTEMS

❖ Microplastic's Impact on Soil Microbial Community

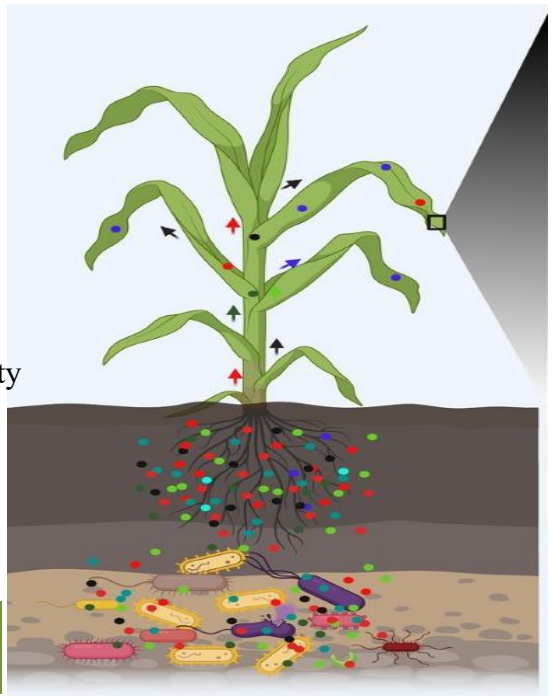

Fig 4. Impact of microplastic on soil biota

Microorganisms are highly abundant in natural ecosystems, with potentially millions of bacterial cells present in each unit of soil. This microbial population plays a key role in ecosystem functions, including nutrient cycling, decomposition of organic matter, and production of essential biochemicals. The presence of microplastics (MPs) in soil can alter the composition of microbial communities, depending on the soil's physical characteristics. Accumulation of microplastics affects soil's physicochemical properties, interferes with the reproduction and development of soil fauna [3,4], modifies enzyme activity, and can influence plant germination (Fig. 4). Microplastics can adhere to the surfaces of soil organisms such as earthworms and springtails, limiting their mobility within the soil layers. Ingestion of microplastics by soil animals, including snails, mice, and earthworms, may cause physical injuries to the digestive tract, intestinal blockages, and adverse biochemical effects such as metabolic disruptions, weakened immunity, and reduced reproductive success. Furthermore, microplastics may create a false sense of satiety in soil organisms, decreasing their intake of carbon-rich food, which can lead to stunted growth, energy deficiency, or even mortality. In addition, microplastics can influence bacterial transport and sedimentation in the soil and may contribute to the reduction of antibiotic resistance genes. Recent studies indicate that widespread microplastic contamination can significantly alter the structure of soil microbial communities, with potential consequences for nitrogen cycling and the global carbon balance.

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❖ **Impact of MPs on Plant Growth and Development**

Fig.5 Impact of MPs on Plant Growth and Development

The presence of plastic residues creates a hostile environment for crops, leading to a cascade of negative growth responses (Fig.5):

1. Physical Growth Constraints

- **Germination Inhibition:** Microplastics can block the pores of seeds, which inhibits water absorption and consequently delays or prevents germination.[5]
- **Root and Shoot Stunting:** Studies show reduced adventitious root development and inhibited overall root growth [6]
- **Yield Reduction:** In staple crops like wheat and corn, microplastics reduce the efficiency of fertilizer use, leading to decreased yields and a lower number of grains per plant.
- **Leaf Morphology:** There is a notable reduction in total leaf area, which limits the plant's capacity for energy production.

2. Physiological and Metabolic Disruptions

- **Photosynthetic Decline:** Microplastic interference inhibits photosynthesis and reduces chlorophyll content, as observed in crops like lettuce [7].
- **Metabolic Impairment:** The accumulation affects the metabolism of amino acids, nitrogen (N), and carbohydrates.
- **Oxidative Stress:** Plants experience increased oxidative stress and disruptions to their antioxidant defense systems.

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❖ **MPs Extraction Procedure by NaCl floatation**

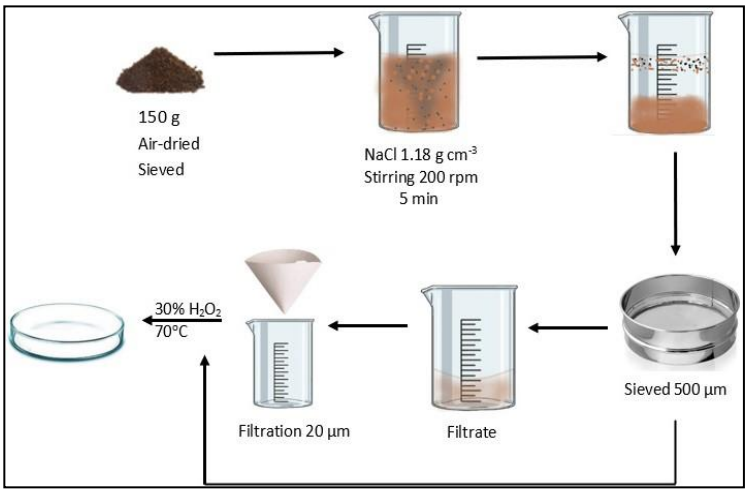
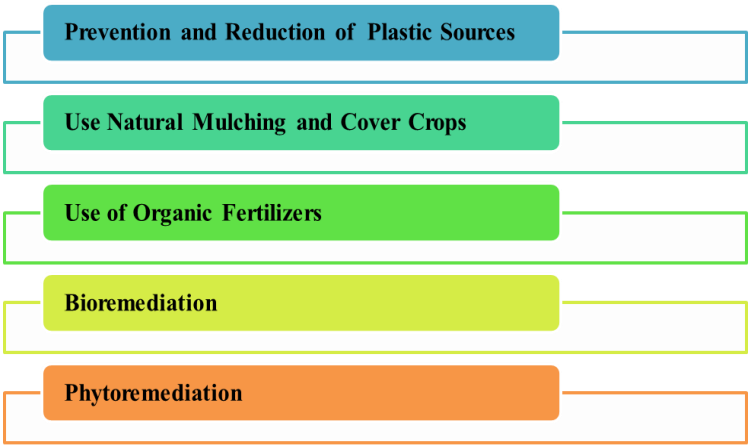


Fig 6. Schematic representation of the MPs extraction procedure by NaCl floatation [8]

❖ **Remediation to Reduce Microplastic Pollution**



Conclusion

Microplastic pollution in soils is a growing environmental concern that threatens soil health, nutrient cycling, and plant growth. Key sources include fertilizers, landfills, sewage sludge, mulch, nursery trays, and wastewater. Despite its impacts, research on soil microplastics is still limited, with significant gaps in understanding long-term effects and standardized assessment methods. Addressing these gaps through interdisciplinary studies is essential to safeguard soil ecosystems and ensure sustainable agriculture.

References

Hanvey, J.S., Lewis, P.J., Lavers, J.L., Crosbie, N.D., Pozo, K., Clarke, B.O., 2017. A review of analytical techniques for quantifying microplastics in sediments. Analytical Methods 9, 1369.

Pinto, J., Da, C., Teresa, R and Armando, C. (2020) The environmental impacts of plastics and microplastics use, waste and pollution: EU and national measures. In: European Union PE.

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Published 30/03/2026

Da, Costa, J.P., Paço, A., Santos, P.S., Duarte, A.C and RochaSantos, T. 2018. Microplastics in soils: Assessment, analytics and risks. Environ. Chem. 16, 18–30.

Ya, H., Jiang, B., Xing, Y., Zhang, T., Lv, M and Wang, X. 2021 Recent advances on ecological effects of microplastics on soil environment. Sci. Total Environ. 798, 149338.

Bosker, T., Bouwman, L.J., Burn, N.R., Behrens, P and Vijver, M.G. 2019**.** Microplastics accumulate on pores in seed capsule and delay germination and root growth of the terrestrial vascular plant Lepidium sativum. *Chemosphere*, *226*, 774–781.

Yan, C., Mei, X., He, W and Zheng, S. 2006**.** Present situation of residue pollution of mulching plastic film and controlling measures. *Trans. Chin. Soc. Agric. Eng. 22*, 269–272.

Gao, M., Liu, Y and Song, Z. 2019**.** Effects of polyethylene microplastic on the phytotoxicity of di-n-butyl phthalate in lettuce (*Lactuca sativa* L. var. ramosa Hort). *Chemosphere*, *237*, 124482.

Isari, E. A., Papaioannou, D., Kalavrouziotis, I. K., & Karapanagioti, H. K. (2021). Microplastics in agricultural soils: A case study in cultivation of watermelons and canning tomatoes. *Water, 13*(16), 2168.