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Microplastics and Soil Health: Unseen Threats Beneath Our Feet

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Introduction

The contamination of soil by microplastics has drawn more attention from stakeholders and environmental specialists in recent years. Microplastics are persistent contaminants that significantly affect agricultural productivity, soil ecology, and the general well-being of the ecological environment. Microplastics have the ability to significantly affect the functioning of soil ecosystems by influencing the physical, chemical and biological characteristics of soil along with the mobility of other toxins in soil. As a result, it is possible to change processes including soil aggregation, litter decomposition, and nutrient cycling. Additionally, through food chains, microplastics may endanger human health and affect soil biota at many trophic levels. Research on microplastics in the soil environment is scarce, despite this possible adverse relationship.

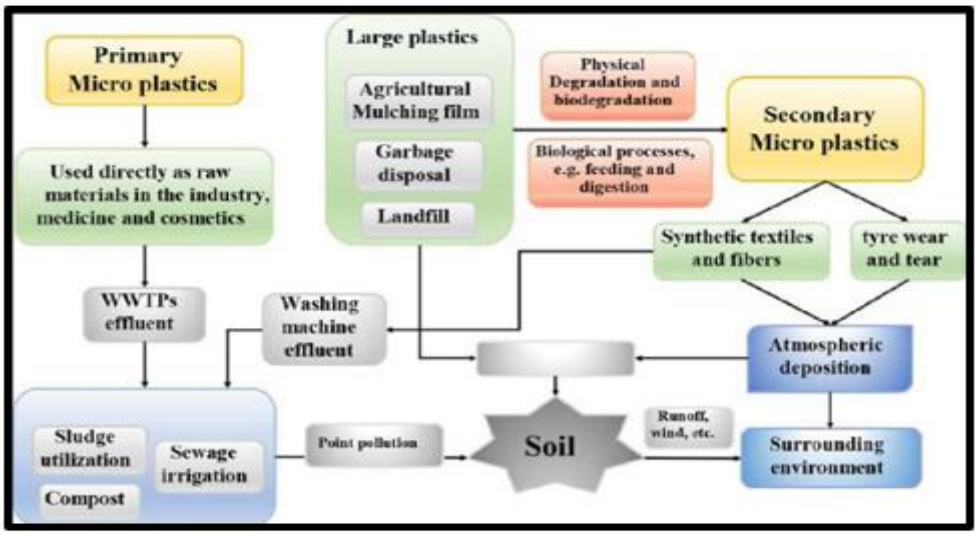

Figure1. Sources of microplastics in soil

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When the existence of tiny plastic threads, granules and fragments in water became known in the 1970s, they were referred to as "microplastics"." These microplastics, i.e. tiny sections of plastic less than 5 mm size, were described as second most important scientific problem in the field of ecology and the environment. Recent research suggests that the amount of microplastics on land could be four to twenty-three times higher than in water. Soil may be a bigger sink than the ocean, and the amount of microplastics in agricultural soils exceeds that in the ocean every year. This pollution of the soil is quite serious.

Effect of microplastics on soil ecosystem

1. **Effect on soil physico-chemical properties:** The microplastics cause's serious issues in the soil environment and when it combines with other organic toxins, its capacity of adsorption is greatly enhanced due to its small size and larger surface area, that alter the soil physical and chemical properties and affect the soil ecosystem health.
2. **Effects on soil microorganisms:** The soil ecosystem depends heavily on soil microbes. Studies have shown a relationship between the activity of soil microorganisms and the physicochemical characteristics and nutrients of the soil. In comparison to soil without microfibers, any modification that incorporates linear microfibers, for instance changes in soil aggregation, will alter the microbial diversity. Conversely, the existence of soil microplastics could serve as a conduit for further poisonous and detrimental materials. The soil ecosystem health will be impacted by the migration of microplastics, which will alter the microbial population and biodiversity of the soil ecosystem. Furthermore, variations in soil porosity brought on by microplastics can affect how oxygen moves through soil, which in order affects the distribution and abundance of anaerobic and aerobic bacteria in soil profile. Furthermore, microplastics have the potential to alter soil pore spaces, which could lead to habitat loss and the extinction of native soil microorganisms.
3. **Effect of microplastics on plants:** In agricultural ecosystems, microplastics can indirectly impact plant seed germination and growth by influencing microbial activity, soil microbial biomass, and functional diversity, as well as cycling of plant nutrient elements in soil. If microplastics persist in soil for a long time, they form nanoplastics, which accumulate and migrate in plants before being consumed by humans through the food chain, ultimately causing ecological harm.

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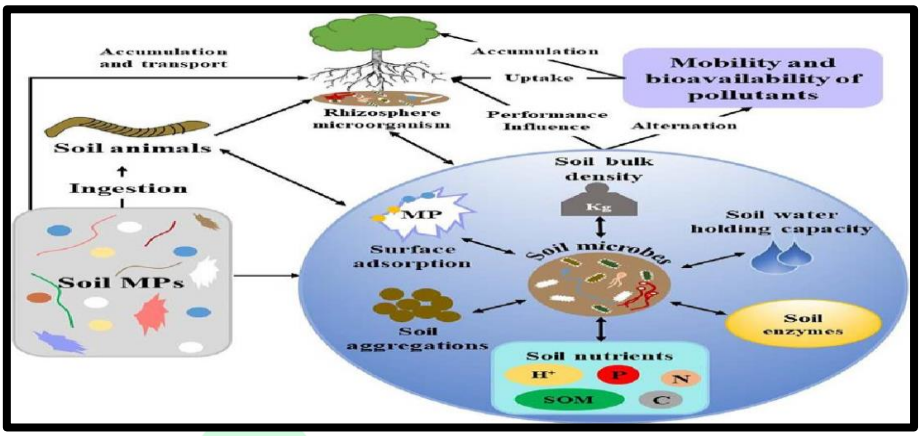

Figure 2. Soil parameters affected by Micro plastic pollutants

From soil to plate: microplastics in the foor chain

Beyond the soil, microplastics continue to travel, entering the food chain and endangering the health of people and animals. In highly contaminated soil, plants can absorb these microscopic particles through their roots. Fruits and vegetables that wind up on our plates include these particles, which accumulate in plant tissues. Grazing animals are also at risk. They consume microplastics directly from the ground or through contaminated water and feed. Their bodies accumulate these fragments, which harms their health and degrades the quality of meat and dairy products. Additionally, soil microplastics can enter rivers and lakes and become a component of aquatic food webs, harming water systems. Consuming food contaminated with microplastics poses serious health risks to consumers. Although the long-term impacts are still unknown, preliminary study suggests potential issues include inflammation, free radical-induced cell damage, and hormone system changes. Even worse, these health hazards can be exacerbated by the chemical additives found in microplastics, many of which are known to be hazardous. We must take immediate action because microplastics are present throughout our food chain. Reducing plastic use, improving garbage disposal, and advancing research on biodegradable materials are important steps to mitigate this expanding issue. Addressing the problem head-on will preserve the health of our food systems, safeguard the health of future generations, and protect soil health.

Prevention and Control: Soil Micrioplastic Pollution

Controlling the buildup of microplastics in the soil environment can be achieved in part by reducing the discharge and use of plastic products from the source. Both American and European nations have passed laws and rules to regulate the source of plastic goods.

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- The United Nations Environmental Programme suggested in 2015 that nations and regions worldwide phase out and outlaw plastic microbeads in cosmetics and personal care items.
- In 2016, the Canadian Federal Government enacted "Regulations on Plastic Microbeads in Cosmetics" after classifying plastic microbeads as harmful chemicals.
- Starting in 2019, Italy suggested outlawing the use of cotton swabs that are not biodegradable nor compostable; from 2020, all cosmetics that contain plastic microbeads, including over-the-counter medications and natural health products, have been prohibited.
- The "Emergency Notice on Immediately Stopping the Production of Disposable Foamed Plastic Tableware" was referenced in the "Plastic Restriction Order" that China issued in 2000. The "Notice on Restricting the Production and Sale of Plastic Shopping Bags" was issued on December 31, 2007, based on the "Plastic Restriction Order." Both the "People's Republic of China's Soil Pollution Prevention and Control Law" enacted on August 31, 2018, and the State Council's "Soil Pollution Prevention and Control Action Plan" published on May 28, 2016, suggested promoting the use of biodegradable films and enhancing the recycling and utilization of waste agricultural film. China is now putting urban trash management and classification into practice.

Challenges in Addressing Soil Microplastic Pollution

Attempts to manage plastic waste try to cut down on plastic that ends up in nature. Yet current rules and laws that deal with soil microplastic pollution don't do enough. Existing rules are often too broad, which makes them hard to put into action. Unclear definitions of rights and duties make it even tougher to enforce these rules. These problems get in the way of good prevention and control plans.

A big issue is the lack of standard ways to collect and study microplastics in soil. This gap stops us from getting a clear picture of how bad the pollution is and makes it hard to come up with targeted fixes. Plus, we need new tech to gather and remove microplastics from soil. The methods we have now don't work well and cost too much leaving soil at risk of ongoing pollution. The lack of good tracking systems makes things worse. Without solid info on where microplastics come from where they end up, and what they do to soil, it's impossible to make good policies. We need scientists, policy makers, and businesses to work together to fix these

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problems. Putting money into research and tech, along with efforts to teach people about the issue, can help us find lasting solutions.

A multifaceted approach is required to address the challengaes in soil microplastic. Strict laws and regulations, waste management practices and advancements in biodegradable materials are crucial steps forward. By underrtaking such challenges, we can protect soil health and ensure cleaner, safe environment for future generations.

Conclusion

Microplastics are becoming common pollutants that are raising concerns around the world due to their toxicity and other detrimental effects on aquatic and terrestrial ecosystems. Even though soil serves as a major reservoir and a carrier of microplastics that spread to other ecosystems, there are surprisingly few research on the contamination of the soil environment by microplastics. Landfills, soil supplements, agricultural films, tire abrasion, and air deposition are the main ways that microplastics infiltrate soil ecosystems. By changing soil structure and interacting with other soil components, microplastics added to soil can have a major impact on organism abundance and soil function. Research on how microplastics affect soil ecosystems and human health is still severely lacking. More thorough research on microplastic contamination in soil is necessary because the impact of microplastics might vary greatly depending on their kind, size, form, and intended use. To stop the contamination from spreading widely and to reduce the risks to the terrestrial ecosystem, we must therefore better understand the migration and degradation processes of various microplastic types as well as their interactions with a range of soil parameters, including soil organisms.