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Editorial: Advanced technologies for remedying environmental pollution in agricultural systems

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Editorial on the Research Topic
Advanced technologies for remedying environmental pollution in agricultural systems

1 Introduction

The environmental degradation spurred by human actions has escalated into a worldwide concern. The global deployment of sophisticated technologies is imperative to mitigate the damage inflicted by the contamination of soil, water, and air (Hoang et al., 2024). It is well-established that environmental pollutants adversely impact the growth and vitality of crops and microorganisms within agricultural ecosystems. Pollutants such as heavy metals, pesticides, nanomaterials, novel contaminants, and various chemicals not only affect the quality and quantity of agricultural produce but also extend their influence to higher trophic levels, including mammals and humans (Dai et al., 2021). The adverse effects of these pollutants on diverse agricultural methods exact a significant economic toll on farmers. Elucidating the intricate physiological and molecular mechanisms that facilitate the elimination of environmental toxins is essential for the development of more advanced technological solutions (Cedeño-Muñoz et al., 2024).

Environmental pollution has become a ubiquitous challenge worldwide, with its impact being particularly pronounced in developing and economically disadvantaged regions (Zhang et al., 2024). The threats posed by environmental pollution extend beyond the immediate effects on crops and microorganisms, reaching into the food chain and ultimately affecting human health. This Research Topic seeks to investigate the toxicity, underlying mechanisms, and potential remediation strategies for environmental pollution within agricultural settings. It delves into the intricate ways in which plants and microorganisms respond to and adapt to new types of pollution, including heavy metals, pesticides, nanomaterials, and emerging contaminants, and the mechanisms they use to neutralize or detoxify these stressors (Jiang et al., 2021). The findings of this research are not only enlightening but also critical for developing sustainable solutions to mitigate the adverse effects of environmental pollution on agricultural systems.

In this editorial, we set up a Research Topic of Advanced Technologies for Remedying Environmental Pollution in Agricultural Systems, which covers up-to-date scientific evidence and the potential for future research to explore the toxicity, mechanism, and remediation underpinnings of any features connected to environmental pollution in agricultural systems. The following themes are included in this Research Topic: (a) Environmental pollution risk assessment for plants and microorganisms in agroecosystems, (b) Environmental pollution-induced biological changes in plants and microorganisms, (c) The underlying physiological and molecular mechanism in plants and microorganisms against environmental pollution, (d) Environmental pollution as a risk to agricultural practices, and (e) Remediation techniques for environmental pollution in agroecosystems.

Despite significant advances in understanding he toxicity, mechanism, and remediation underpinnings of any features connected to environmental pollution in agricultural systems, there remain knowledge gaps in these areas, and our Research Topic aims to address these gaps. In the end, we accepted and published five articles (3 Original Research and 2 Review) written by 21 researchers from six different countries, e.g., United States (7), China (7), Ethiopia (3), Republic of Korea (2), Canada (1), and Bangladesh (1).

The review articles 'Biochar as a tool for the improvement of soil and environment' and 'Bioremediation of petroleum hydrocarbon contaminated soil: a review on principles, degradation mechanisms, and advancements' were reviewed by Kabir et al. and Mekonnen et al. The original research articles 'Developing a hybrid data-driven and informed model for prediction and mitigation of agricultural nitrous oxide flux hotspots', 'Removal of microplastics from agricultural runoff using biochar: a column feasibility study', and 'Sheep manure organic fertilizer is an effective strategy to promote strawberry growth by improving soil physicochemical properties and microbiota' were written by Vemuri, Olubusoye et al., and Zha et al.

2 Review

Kabir et al. review yields valuable insights that are expected to bolster the practical usage of biochar in farming. Their review promises to tackle climate change through a variety of channels, including sequestering carbon from the atmosphere, boosting soil productivity, and reducing the emission of greenhouse gases. This review uncovers a promising route for harnessing biochar's capabilities, mapping out a trajectory towards a future that is both sustainable and resilient.

Mekonnen et al. have shed light on the foundational principles underpinning the bioremediation of petroleum hydrocarbons (PHC), as well as the intricate degradation mechanisms at play. They have also examined the constraints inherent in the bioremediation process and highlighted cutting-edge advancements driving the field forward. Consequently, gaining a comprehensive understanding of the degradation pathways, guaranteeing the thorough breakdown of pollutants, and advocating for adaptable regulatory frameworks concerning the deployment of genetically modified microorganisms are pivotal steps toward making bioremediation a more sustainable and economically viable solution.

3 Original research

Vemuri discovered that the informed network demonstrated outstanding performance even when utilizing minimal portions of the training dataset, achieving an F1 score of 0.41 using just a quarter of the training data. This model not only exhibits significant potential for the exceptionally precise forecasting of these hotspots but also represents a promising novel approach for the integration of physics-based knowledge in machine learning methodologies within the environmental and agricultural disciplines.

Olubusoye et al. found that smaller microplastics (MPs) delved deeper into the columns; however, a staggering 90% or more of the MPs were effectively retained within the approximately 20-cm columns, irrespective of their form, dimension, or classification. These findings can be ascribed to phenomena such as physical trapping, hydrophobic tendencies, and electrostatic forces. In summary, this pioneering study indicates that biochar could be a financially viable method for extracting MPs from runoff, and it justifies the need for further field investigations.

Zha et al. conducted a redundancy analysis (RDA) which revealed that the pivotal factors influencing bacterial communities in the soil were nitrate nitrogen (NN) and rapidly available potassium (RAP), whereas the fungal communities were primarily affected by alkaline dissolved nitrogen (ADN) and ammonium nitrogen (AN). In essence, the use of various fertilizers facilitated the liberation and conversion of soil nutrients by impacting the composition and variety of bacterial and fungal assemblages in strawberry fields. This process proved advantageous for the replenishment of soil nutrients and the enhancement of soil health. Notably, the incorporation of sheep manure-based organic fertilizer yielded the most substantial improvements in soil quality.

4 Prospect

Human activity has led to a global environmental crisis, with soil, water, and air contamination posing serious threats to agricultural systems. This Research Topic aims to explore the toxicity and mechanisms of environmental pollutants like heavy metals and pesticides, and to develop innovative remediation techniques. By understanding how plants and microorganisms cope with these pollutants, we aim to create sustainable agricultural practices that protect both the environment and farmers' livelihoods. The research will drive the development of advanced technologies and inform global policies to combat environmental pollution in agriculture.

Author contributions

ZY: Writing–review and editing. YW: Writing–review and editing. SD: Writing–review and editing. MJ: Writing–original draft, Writing–review and editing.

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Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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