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Editorial

The Properties of Microorganisms and Plants in Soils after Amelioration

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Soil, as a vital foundation of the Earth's biosphere, supports plant growth, carbon storage, water cycling, and nutrient supply, making it a crucial resource for ensuring global food production and ecosystem health [1–3]. Healthy soils can maintain efficient nutrient cycling, support biodiversity, and provide sustained agricultural productivity for human societies [4–6]. However, under the combined impact of population growth, land overuse, industrialization, and climate change, soils worldwide are facing unprecedented degradation and pollution challenges [7,8]. These issues not only lead to a decline in soil productivity and reduced crop yields but also trigger biodiversity loss, the depletion of soil carbon stocks, and the deterioration of water resources, thereby threatening global ecological security and sustainable development goals [9–11].

In this context, soil amelioration has become a critical research area to combat soil degradation, restore soil function, and promote sustainable agricultural development [12–14]. Soil amelioration techniques aim to improve soil structure, enhance fertility, increase water retention capacity, and stimulate microbial activity through physical, chemical, and biological means, thereby restoring soil health [15,16]. Whether through traditional practices such as organic matter addition and liming or emerging technologies like biochar application, cover crops, and microbial inoculants, soil amelioration measures have been widely applied and extensively studied worldwide [17–19]. These measures provide effective pathways for restoring soil health and lay the foundation for sustainable agriculture and environmental management. Indeed, soil amelioration remains a cornerstone in the quest for sustainable agricultural practices and environmental management [20,21].

As the challenges of soil degradation continue to threaten food security and ecosystem resilience, the importance of innovative soil amelioration techniques is becoming increasingly evident [22]. Consequently, globally, scientists and practitioners are dedicated to exploring more efficient and sustainable soil amelioration methods to address evolving environmental pressures and enhance soil adaptability and resilience. This Special Issue has been developed within this context, gathering cutting-edge research to explore the effects of various soil amelioration methods on soil properties, microbial communities, and plant growth. Through these studies, we aim to deepen our understanding of the mechanisms and impacts of soil amelioration and provide valuable scientific insights and practical guidance for future soil management and agricultural sustainability.

The role of biochar in soil improvement is a key focus of this issue. For example, Sun et al. (2023) have demonstrated that exogenous organic matter, such as straw and straw biochar, significantly impacts soil carbon and nitrogen dynamics, with important implications for soil carbon sequestration and nitrogen availability. The interaction between straw and biochar reveals a nuanced understanding of carbon and nitrogen priming effects, shedding light on the temporal changes in microbial activity and nutrient cycling. Additionally, Song et al. (2023a) have explored the role of biochar derived from various agricultural residues in enhancing soil health. Their study found that biochars produced from tropical crop wastes at different pyrolysis temperatures significantly influence soil pH, nutrient availability, and microbial diversity. These findings underscore the importance of feedstock selection and pyrolysis conditions in determining the efficacy of biochar as a soil amendment. Moreover, He et al. (2023) have evaluated the effects of successive seasonal applications of rice straw-derived biochar on the acidity and fertility of soil. They demonstrated that the application of rice straw-derived biochar to soil at 22.5 t ha^{-1} was found to be highly consistent in decreasing soil acidity and reducing soluble and exchangeable Al^{3+}, indicating its higher ameliorating capacity in the south of China in the long run.

Furthermore, the impact of soil amelioration on heavy metal dynamics in contaminated soils, such as cadmium immobilization through biochar application, represents an area with significant implications for environmental safety and crop production. To this end, Yuan et al. (2023) investigated the mechanism of fixation of cadmium in submerged paddy soil at different pyrolysis temperatures in a study, revealing that the application of rapeseed straw biochar enhances cadmium immobilization by promoting the formation of sulfide and poorly crystallized Fe oxide in paddy soil. This work highlights the importance of biochar's redox capacity in cadmium immobilization under conditions affecting flooding, thereby providing new insights into the potential of biochar for cadmium remediation in rice cultivation.

Long-term field experiments are indispensable for understanding the sustained impact of soil amelioration practices, particularly in relation to nutrient cycling and microbial dynamics. Song et al. (2023b) explored the relationship between soil phosphorus (P) forms and microbial communities under long-term fertilization through an extensive field experiment involving 26 years of continuous maize cropping in Northeastern China. Moreover, Liu et al. (2023) have documented the long-term use of organic fertilizers and encouraged Fe immobilization in organo–inorganic compounds. However, the application of a nitrogen fertilizer alleviated the Fe retention induced by the organic fertilizer.

This Special Issue presents a comprehensive examination of the soil amelioration strategies and their effects on soil properties, microbial dynamics, and environmental outcomes. The collective findings advance our knowledge of soil management practices, emphasizing the importance of organic amendments, biochar, and long-term field studies in achieving resilient and productive soils. We hope that these contributions will inspire further research and practical applications, paving the way for more sustainable and effective soil management solutions.

Conflicts of Interest: The author declares no conflicts of interest.

List of Contributions:

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