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Editorial: Soil-plant-microbe interactions: An innovative approach towards improving soil health and plant growth

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Editorial on the Research Topic
Soil-plant-microbe interactions: An innovative approach towards improving soil health and plant growth

The loss of soil health is one of the major obstacles to attaining agricultural sustainability. This loss is typically caused by the adoption of poor farming practices and the excessive use of chemicals, such as fertilizers and pesticides (Kumar et al., 2017; Kumar et al., 2018). One potential strategy to stop this deterioration in soil quality is the application of microbial inoculants to the soil or plant parts (Banik et al., 2019). Understanding how microbes function in the plant-soil system's biogeochemical cycling, as well as in processes like the reduction of toxins, nutrient dynamics, antioxidant activity, systemic induction of resistance, pathogen suppression, etc., is essential if we are to fully utilize their potential (Govindasamy et al., 2008). In addition to improving product quality and environmental health, these interactions will lessen the toxicity of synthetic chemicals and other pollutants. This special issue covers the aspects related to the relationship between soil, plants, and microbes to enhance soil health and plant growth, which is especially helpful for comprehending the sustainability of agricultural systems.

In this Research Topic, the prevalence and potential management strategies of plant diseases in horticulture crops, including tomato fusarium wilt, apple replant disease (ARD), and kiwifruit early decline syndrome, have been examined. The factors of kiwifruit early decline syndrome were triggered due to the interaction between climatic conditions and agronomic soil management. Hence, properly managing these conditions might be useful to suppress the kiwifruit early decline syndrome (Bardi et al.). Whereas ARD disease was overcome by creating a new microbial community structure favorable to plant growth when ZnO-NPs were added to the soil (Pan et al.). On the other hand, Chaturvedi et al. highlighted the application of bacterial endophyte consortium to protect the photosynthetic system in tomato against fusarium wilt.

Rhizospheric and endophytic beneficial microorganisms play a crucial role in promoting plant growth and improving soil health. The rhizospheric microbes improve soil fertility, regulate pH, and protect crops from phytopathogens. Meanwhile, endophytes can contribute to improved nutrient uptake and increased tolerance to biotic and abiotic stresses. According to Dounas et al., the biological invasion of sand dunes by the exotic shrub had favorable effects on the chemical makeup and functionality of the soil due to the activity of rhizobacteria in fixing atmospheric nitrogen and the bioavailability of phosphate by the native mycorrhizal community. Agbodjato et al. also showed that the addition of 25% chemical fertilizers after inoculation of mycorrhiza (strains of Glomeraceae and Acaulosporaceae) in maize plants had a favorable effect. *Pseudomonas* spp. in finger millet was found to promote plant growth by releasing lytic enzymes and secondary metabolites (Waghunde and Sabalpara). In another report, Malviya et al. discovered two potential sulfur-oxidizing bacterial species (*Stenotrophomonas maltophilia* DRC-18-7A and *Stenotrophomonas pavanii* DRC-18-7B) that could be utilized as inoculants in pigeon pea to boost its growth and yield. Potent local rhizobia isolates (*Rhizobium tropici* clone H53, *Mesorhizobium* sp. WSM3874, and *Rhizobium pusense* strain Nak353) in small-holder farms has the significant potential to enhance cowpea growth and yield in response to climate change (Nyaga and Njeru).

To reduce the impact of abiotic stress in different crops, it is increasingly imperative to isolate and characterize potent microorganisms that help plants to cope with adverse conditions. Five ACC deaminase-producing bacteria that can alleviate drought were discovered by Sharath et al. from the cotton phyllosphere. These bacteria included *Pseudomonas stutzeri*, *Acinetobacter* sp., *Bacillus mojavensis*, *Pseudomonas chlororaphis*, and *Enterobacter asburiae*. Like this, Nagaraju et al. also developed an ACC deaminase-positive fermentative halophilic bacterial consortium that improved chickpea plant growth and yield in saline environments.

According to Wang et al., parameters of soil physicochemical and plant qualities were substantially connected with soil microbial properties, demonstrating how these variables can respond favorably to the natural restoration process of reclaimed marshes. On the contrary, Kumar et al. hypothesized that the conversion of the Sundarban and Bhitarkanika mangroves into rice agriculture negatively impacted the microbial diversity, hence affecting natural sustainability. Following the harvest of faba bean or oilseed rape, Rothardt et al. found that substituting organic amendments with high C:N ratios (such as winter wheat straw and sawdust) for the initial crop residues can lower N_2O emissions over the fall and winter by up to 45%. According to the report by Freidenreich et al., CO_2 emissions, particularly during the growing season of cover crops, were significantly influenced by soil and air temperature.

In this Research Topic, Padbhushan et al. report on a few studies that are part of a meta-analysis that includes trend analysis of integrated nutrient management (INM) and land use changes (LUC) in Indian agriculture. The study demonstrated that INM might be an economically and environmentally sustainable farming system mode in India for enhancing crop yield, raising soil carbon sequestration, and enhancing microbial activity. Following a decrease in the usage of chemical fertilizers, Kumar et al. integrated the fertilization of potassium through farmyard manure and murate of potash, which showed the most promising influence on soil biological activity and yield of wheat crop. Padbhushan et al. also revealed that the soil carbon pools decreased as LUC transitioned from native forestland to other LUs and suggested to adopt crop-production systems that can reduce CO_2 emissions from the intensive LUs under Indian Agro-climatic conditions.

In the acid soils of the Indian sub-Himalayan area, agroforest systems (AFSs) based on hedges and alder may be encouraged to achieve climate-smart agricultural practices (Parmar et al.). In order to combat widespread malnutrition and acute zinc deficiencies in humans and livestock in the North-Western Himalayas, Choudhary et al. demonstrated how the system of rice intensification (SRI) in combination with the recommended dose of fertilizers and zinc in hybrid rice assumed a greater significance.

In the eastern Indo-Gangatic plans, Sahoo et al. hypothesized that an appropriate combination of irrigation and nitrogen levels in zero-till wheat may not only produce high yields and N usage efficiency but also effectively reduce NO_3-N leaching under acidic alluvial soils. According to Sahoo et al., alternate tillage treatments with recommended levels of crop residue and fertilizer (75% of the recommended N as fertilizer and 25% of the recommended N as vermicompost) were found to improve soil microbiological activity and maintain soil carbon and nitrogen levels. Therefore, farmers in India's Terai region should be advised to use various tillage techniques and integration of chemical and organic fertilizers. Diversification of production systems through the adoption of conservation agriculture and organic farming has been reviewed by Shahane and Shivay, which is worth considering their role in soil health improvement.

In contrast to fungus and actinomycetes, bacteria dominated the soil microbial communities. Bacteria and actinomycetes populations in *Prunus fruticose* rhizosphere and non-rhizosphere soil showed a decreased trend with elevation (Liu et al.). Recent research suggests that the host genetic factor may facilitate the study of microbiome diversity and structure, which may aid in selecting microbiomes based on various features (Sharma et al.). Advanced integrated novel molecular approaches, such as ecological models, meta-omics, genome editing, and bioinformatics, are required to explore broader knowledge of host-specific plant-microbe interactions (Shelake et al., 2019). These approaches could connect the relationship between the microbial community and environmental function. A review on the Synthetic Microbial Communities (SynCom) technique has been published in this issue by Shyanthan et al. SynCom is a new method that comprises co-cultures of several taxa under certain conditions to imitate the composition and operation of a microbiome (Shyanthan et al.). Through synergistic interactions amongst its members, the SynCom approach aims to strengthen the stability of microbial communities, and its practical use in agriculture will be taken into consideration.

Finally, we believe that this Research Topic on "*Soil-Plant-Microbe Interactions*" will provide insights into recent advances in the use of microbial inoculants to enhance crop yields while preserving soil health.

Author contributions

UK wrote the first draft of the editorial. RMS and RS edited the draft and also made additional contributions. All authors contributed to the article and approved the submitted version.

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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.

Publisher's note

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