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Editorial: Plant holobiont perspective in plants disease management

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Editorial on the Research Topic
Plant holobiont perspective in plants disease management

Plants interact dynamically with various microbial communities in the rhizosphere, phyllosphere, and endosphere. These communities receive nourishment and carbon from plants and harbor a diverse array of species, some of which are beneficial to plants. Although the microbial communities associated with plants present a high density of members, not all microorganisms are equally desirable, and only those that contribute positively to the wellbeing of plants are welcome in these microbial communities. The microorganisms chosen by the host plant have varying abilities that significantly affect plant growth. They contribute to the finesse and overall health of the plants. The host plant and colonizing microorganisms together form a functional unit, referred to as the holobiont. The holobiont of a plant is a dynamic community whose structure and composition are influenced by a range of factors, such as environmental conditions, the health status of the plant, and disruptions to the microbiome that result in an imbalance in the microbiota and decrease the positive effect exerted by these microorganisms on plants.

Certain studies have revealed the impact of the plant microbiome on plant health and productivity; however, there is a lack of information on how to manipulate these microorganisms to achieve optimal results.

The plant microbiome comprises microorganisms that can enhance the accessibility of nutrients in the soil, optimize the uptake of nutrients and water by plant roots, and encourage root growth. Additionally, they can improve photosynthesis, resulting in increased shoot dry mass, and bolster plant immunity against pathogens and pests.

It is interesting to note that plants release various substances from their roots into the soil in a heterogeneous manner. This has two significant consequences. First, it leads to an increase in microbial diversity, as different microorganisms have their own unique nutritional requirements, and these microorganisms occupy specific niches in the plant roots, where the compounds they need are released. Second, competition among microorganisms to colonize the same niche is not universal.

In other words, each microorganism competes with other microorganisms that are also vying for the same niche. This promotes high microbial diversity and allows plants to benefit from the diverse abilities of these microorganisms.

The microbial communities associated with plants provide numerous benefits and ensure a nutritional supply under a variety of environmental conditions. It is noteworthy that different environmental conditions can be advantageous for certain microbial populations but detrimental to others. However, if these communities are capable of providing the necessary nutrients to the plant, the plant will be adequately supplied, regardless of environmental conditions. This phenomenon is known as functional redundancy.

Globally, agriculture faces numerous obstacles in its efforts to sustain and ensure food security. As a result of detrimental farming practices, several issues related to economic loss and environmental degradation have arisen. These include soil salinization, which reduces the capacity of plants to absorb water and nutrients and limits the land available for production, as well as soil contamination with heavy metals. Additionally, eutrophication promotes the death of fish and diminishes the capacity to collect water for drinking fit for human consumption. Moreover, eutrophication facilitates the spread of various diseases. The use of microorganisms associated with plants represents a promising solution to overcome the challenges faced by global agriculture. By employing these microorganisms, it is possible to reduce the expenses associated with food production and minimize the environmental consequences. However, a comprehensive understanding of the interrelationships between the host plant and the affiliated microorganisms is essential.

The following Research Topic discusses the use of microbes as a promising solution to address current agricultural challenges, as presented in three articles included in this Research Topic. These articles, along with the reviews and research pieces, have focused on the capabilities and effects of plant-growth-promoting microorganisms on plant development and wellbeing. In this summary, we highlight the key points from three articles published on this particular Research Topic.

Martinez et al. demonstrated that routine applications of pesticides and/or N-fertilizers may inadvertently reinforce the problem of Pests and Pathogens (P&P) damage in agriculture by enhancing the nutritional quality of crops for these organisms. N-fertilization has a diverse influence on the susceptibility of crops to P&P damage; N-fertilizers enhance the nutritional quality and "attractiveness" of crops for P&Ps, and they can also alter a crop's expression of the defensive traits (both morphological and chemical) that serve to protect them against these organisms. Exposure of crops to pesticides (including commonly used insecticides, fungicides, and herbicide products) can result in significant metabolic disruption and, consequently, the accumulation of nutritionally valuable amino acids within crop tissues. This condition favors the establishment of several pathogens and pests.

Kebede addressed how rhizobial inoculation advances agricultural production by improving plant growth, nutrient availability and uptake, and yields by enhancing the bio-fixation of atmospheric nitrogen and solubilization of soil nutrients. In addition, rhizobial inoculants offer biocontrol of plant diseases by providing resistance against disease-causing pathogens or suppressing diseases. The mechanisms involved in the biocontrol of plant diseases include competition for infection sites and nutrients, activation of induced systemic resistance, and production of substances such as growth hormones, antibiotics, enzymes, siderophores, hydrogen cyanide, and exopolysaccharides. Consequently, this approach is promising, as sustainable agricultural practices are yet to supplement or replace chemical fertilizers, serving as a basis for future research on sustainable agricultural production. Despite the multifunctional benefits of rhizobial inoculation, there are variations in the implementation of this practice by farmers. Therefore, researchers should work on eradicating farmers' constraints in using rhizobia, and future studies should focus on methods for improving inoculant quality and promoting this technology.

Adedayo et al. showed that using the SEED subsystem revealed that a total of 15 functional categories dominated the healthy rhizosphere, and seven functional categories dominated the diseased rhizosphere. At the same time, six functions dominated in the bulk soil. Alpha (α) diversity assessment did not reveal a significant difference ($p > 0.05$) in all the soil samples, but a considerable difference was observed for beta (β) diversity ($P = 0.01$). The functional categories obtained in this study were highly abundant in the HR. Therefore, this study showed that the functional groups of the rhizosphere microbiomes were more abundant in HR samples than in other samples. The high prevalence of functional groups associated with rhizobiomes in the tomato rhizosphere indicates the need for further research to establish functional genes associated with these rhizosphere microbiomes.

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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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