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Editorial: Plant growth-promoting microorganisms for sustainable agricultural production, volume II

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Editorial on the Research Topic
Plant growth-promoting microorganisms for sustainable agricultural production, volume II

Plant growth-promoting rhizobacteria are a group of bacteria, initially rhizospheric, that have several abilities related to plant growth. These abilities are classified as direct when their effect acts on the plant directly or indirect when their effect acts on the pathogen that attacks the plant. Direct effects on plants are the ability to fix atmospheric nitrogen. Some bacteria have an enzyme named nitrogenase that can transform atmospheric nitrogen into ammonia, making it available for plants and microorganisms. Another direct ability that acts on the plant directly is the ability to solubilize phosphorus. Usually, there is a significant amount of phosphorus in the soil, but it is unavailable because phosphorus is adsorbed in the clay. The microorganisms that can solubilize phosphorus produce enzymes such as phytase or phosphatase or organic acids that solubilize phosphorus, making it available for plants and other microorganisms. Some microorganisms can produce phytohormones, usually indole 3 acetic acid. This phytohormone promotes root development, increasing its efficiency in exploring the soil and its capacity to absorb nutrients and water. It also makes the plant more tolerant to abiotic stress, especially drought. In addition, the phytohormone promotes areal development and increases the chlorophyll content in the leaves. This action promotes an increase in photosynthesis efficiency.

Some microorganisms induce plant growth indirectly. Several microorganisms contain molecules named elicitors. Plants recognize these elicitors, promoting the expression of many genes related to defense mechanisms. This phenomenon is called induced systemic resistance; the plant stays in a state of defense, becoming more resistant to several diseases. Another indirect effect on the plant that promotes plant growth is the capacity of some microorganisms to kill phytopathogenic microorganisms. Some beneficial microorganisms can use some nutrients more efficiently as iron than others, killing these microorganisms for competition. Another strategy is competition for a colonization niche where the beneficial microorganisms colonize the place first, and then pathogenic microbes damage their colonization.

As described, there are many abilities that beneficial microbes of plant growth-promoting microorganisms can promote plant growth, and these microorganisms can be used in crop production as an excellent strategy to face many challenges in the current

scenario. As these microorganisms can promote root development, they can be used to reduce the amount of chemical fertilizers. As these microorganisms can reduce the phytopathogenic microbes and promote induced systemic resistance in the plant, they can be used to reduce the amount of fungicides and pesticides.

Many biotic and abiotic factors influence the efficiency of the mode of action of these beneficial microorganisms on the plant. The challenge is now to improve our understanding of these microorganisms and use them better. Many factors related to plant–microbemicrobe interactions need to be improved. Nevertheless, there are many possibilities to use these microorganisms to improve crop production, reducing production costs and environmental impact without reducing productivity.

In this Research Topic, four studies demonstrated the potential use of microorganisms.

Betran-Medina et al. reported the potential of a *Rhizobium* strain in a non-legume crop to improve P management.

Gaspar et al.a showed a new composter, and the addition of inoculants contributed significantly to the efficiency of the process of composting organic waste.

Gaspar et al.b showed that the yeasts *Pichia kudriavzevii, Pichia farinosa,* and *Issatchenkia orientalis* and the filamentous fungi of the genus *Aspergillus* spp. proven to have high biotechnological value and could be used as starter cultures to accelerate the composting process.

Volkogon et al. showed that pre-sowing seed inoculation had no significant effect on the vertical migration of nutrients in the soil on the background of cattle manure due to the highly competitive environment created by introducing microorganisms from organic fertilizer, preventing the establishment of close interactions between PGPR and plants.

Author contributions

All authors listed have made a substantial, direct, and intellectual contribution to the work and approved it for publication.

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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