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Root Associated Microorganisms – Friends or Enemies?

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Editorial

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Plants constantly interact with different types of microorganisms from soil microbial communities - the greatest reservoir of biological diversity in the world [1]. The seeds and roots surfaces provide ideal habitats for microbial growth, being in the same time the place where intense interactions occur between microorganisms and plants. Many important microbial mediated processes, including plant growth promotion, plant protection, pathogenesis, competition etc. occur in the rhizosphere - the area of soil surrounding the roots which is most exposed to the influence of plant roots exudates [2]. The structure of rhizosphere microbial communities differs from that of the bulk soil, suggesting that plants are able to shape their microbiome [3,4]. The rhizosphere microbiome is very diverse comprising bacteria, fungi, nematodes, protozoa, algae and microarthropods. Though, the dominant population of the rhizosphere is made up by species belonging to Proteobacteria and Actinobacteria [2].

Plant-microbe interactions at the root level can be considered beneficial, harmful or neutral to plants [5]. Therefore, establishing the costs and gains of the interactions between plants and root associated bacteria it is important not only for understanding the basis of those processes but also for designing of new strategies for improving crop yields.

Attracted by the root exudates, soil bacteria colonize the rhizosphere and promote the plant growth by facilitating the nutrient uptake (N, P), producing phytohormones (auxin, gibberellins, cytokinins), enhancing their resistance to biotic and abiotic factors such as pathogenic fungi and bacteria, extreme temperatures, heavy metals, salinity. The best known example of beneficial microorganisms is the mycorrhizal fungi that form symbiosis with approximately 80% of all terrestrial plant species by delivering nutrients for the plants in return for photosynthates. Beneficial interactions also occur between symbiotic bacteria belonging to *Rhizobium* genus and leguminous plants in which the bacteria fix atmospheric nitrogen for the plant. Besides symbiotic beneficial association, free living rhizosphere microorganisms that include plant growth promoting rhizobacteria (PGPR) can positively affect the plant growth [4]. The benefits of plant-PGPR interaction include: increases in seed germination rate, root growth, yield, leaf area, chlorophyll content, nutrient uptake, protein content, hydraulic activity, tolerance to abiotic stress, shoot and root weights, bio control and delayed senescence [6,7].

Root exudates can equally attract beneficial microorganism and pathogenic population that can have negative impact on the plant growth by production of phytotoxins, competition for nutrients, inhibition of myccorhizal fungi or by inducing diseases or even plant death [2,8]. Microorganisms that are deleterious to plant health include pathogenic fungi, bacteria and nematodes.

Sometimes the same mechanism used by soil microorganisms can induce opposite effects. For example bacterial auxin production can either stimulate the plant growth or can enhance the bacterial gall formation, its synthesis being associated with pathogenesis. Also, bacteria can behave as pathogens or symbionts depending on the environmental conditions such as light, nutrient, water or temperature stress, size of inoculums, host developmental signals [9]. The bacterial pathogen *Erwinia artroseptica* can be beneficial for its hosts due to its nitrogen-fixing genes, but in the same time, in certain agricultural conditions, it can be harmful by inducing diseases such as potato blackleg [10]. Many rhizobacteria can stimulate the nutrient uptake but in the same time can affect in a negative manner the growth of the plants by the competition for nutrients (sequester the available nutrients before roots can gain access to them).

However, being a friend or a foe to plants depends on many factors such as root exudates composition, the ability of bacteria to overcome the plant defense system, the plants ability to fight against pathogenic attack, the plant species and the genetic traits

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that can influence the microbial diversity and its influence on the plants growth and health, the environmental conditions etc. A better understanding of the plant-bacteria interaction is necessary for the bacteria to be considered a friend or an enemy to plants since there are many mechanisms and factors involved.

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