Provisional chapter

Introductory Chapter: Symbiosis - A Successful Association between Plants and Microorganisms

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Additional information is available at the end of the chapter

1. Introduction

1.1. Plant growth promoting

In the last century, the use of chemical fertilizer has increased annually in the agriculture crops, and also the demand for food production has been increased.

Since the green revolution, the plants have been modified to become each more productive; therefore, the need for chemical fertilization has been increased.

However, the efficiency of plants to use or to uptake these nutrients from chemical fertilizers is too small, and the losses of these nutrients are too high. The agriculture system is based on the input and the output. Moreover, the problem becomes higher when the amount of fertilizer is higher than necessary to offset your losses. This condition causes many environmental and human health problems. Moreover, when the chemical fertilizers have been used, the ability of the plant roots to look for the nutrients and the abilities of many microorganisms to provide them for plants are ignored.

Since the emergence of plants, the association between plants and microorganisms has become strong. Moreover, both plants and microorganisms have gained with this association.

The plant and its microbiota interactions initiated since the emergences of the plant on Earth. These associations were required because the soil fertility when the plants emerged was very low and the microorganisms presented efficient abilities to uptake these low nutrients from the soil. These associations were responsible for the success of the plants to colonize on Earth.

The associations between plants and microorganisms continue till date. The symbiosis is most elevated and complex association between plants and microorganisms. It represents an evolutionary

success, in which many mechanisms at both plants and microorganisms are required to be developed such as molecular interactions, cell surface receptors, metabolic interactions, and maybe the important characteristic the symbiosis had been is the gene expression control by microorganisms.

Interestingly, in the first moment, maybe the symbiotic microorganisms were saprophytic. This characteristic requires that these microorganisms should obtain nutrients for their survival from the dead organic matter. These kinds of microorganisms are not able to obtain nutrient from the live tissue. It is certain because they are not able to suppress the plant protection mechanisms. When in the dead organic matter, the difficulty would be to just solubilize the organic matter.

Beneficial or parasitic interactions between plants and microorganisms are similar. In both situations, the microorganisms need to overcome the defense mechanisms of plants, and the difference among them is the beneficial interactions the microorganisms learned their capacity to get nutrients and metabolic from the plant without damaging.

The dynamic nature of the soil is a direct manifestation of soil microbes such as bio-mineralization and synergistic co-evolution with plants. The microorganisms succeeded in colonizing several plant's organs such as root and leaf.

Both the leaf and root microbiota contain bacteria that provide indirect pathogen protection and serve as additional host functions through the acquisition of nutrients from the soil for plant growth. In this context, the plant microbiota emerges as a fundamental trait that includes mutualism through diverse biochemical mechanisms, as reported by several studies on plant growth promoting and plant health. Although there is a wide variety of plant growth promoting rhizobacteria, members of plant's microbiota, their roles, and usages for sustainable agriculture remain controversial and restricted.

Some microorganisms have many beneficial characteristics that can be used to promote plant.

The largest part of the nitrogen is on the air, and few organisms are able to obtain and use it. Therefore, some microorganisms have the ability to get atmospheric nitrogen and transform it into an organic molecule. This phenomenon is termed nitrogen biological fixation. By this way, the plant can uptake and use this nutrient for its growth. Other microorganisms have the ability to produce organic acids or enzymes such as phosphatases and phytases. These microorganisms can solubilize the phosphorus adsorbed into the soil, mineralizing it and providing it for plants.

Other groups of microorganisms are able to synthesize phytohormones. It is an interesting characteristic for both microorganisms and plants. The microorganisms produce phytohormones because it cancels the plant protection mechanisms against the microorganisms and additionally promotes the root and shoot growth. When the root grows, the microorganisms become more efficient to uptake the nutrients released from the root. Consequently, the root growth promotes plant development, the plant becoming more resistant to hydric and nutritional stresses.

Another important characteristic of some microorganisms is the interference of *quorum sensing* between bacteria. The individuals of microbial community communicate with each other

through some molecules termed elicitors. Interestingly, when the concentration of these elicitors is low, the communication between bacteria does not happen. When the concentration of these elicitors is high, some genes belonging to the bacteria of the microbial community are expressed, and the new microbial characteristic arises. When the beneficial microbes are inoculated into the plant, some bacteria produce some molecules that destroy these elicitors, impairing the communication between pathogenic bacteria and avoiding any damage to plants.

Finally, some beneficial bacteria produce several antimicrobial molecules against many pathogenic microorganisms. This characteristic promotes a reduction of damage caused by pathogenic bacteria against plants.

In this context, this book entitled symbiosis had to report some different aspects related to this complex biological phenomenon between plants and microorganisms as aim, demonstrating the importance of it for plants and how it could be used as a strategy to improve the yield in crop production.

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