Biotica Research Today

Vol 3:9 791/792

2021

Plant Probiotics: A New Green Revolution

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Open Access

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Keywords

Biocontrol, Green revolution, Mechanisms, Probiotic Bacteria

Article History

Received in 12th September 2021

Received in revised form 21st September 2021

Accepted in final form 22nd September 2021

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How to cite this article?

Greeshma *et al*., 2021. Plant Probiotics: A New Green Revolution. Biotica Research Today 3(9): 791-792.

Abstract

With the growing population need of producing abundant food in the same piece of land resulted in intensification of agriculture causing high usage of pesticides and fertilizers. Unfortunately, the high and indiscriminate usage of the chemicals resulted in depletion effects on soil, water, human and animal health. Some terrestrial bacteria harbour some of the mechanisms to enhance plant growth, which includes the biocontrol of plant pathogens, nutrient mobilization, phyto-stimulation and abiotic stress protection. Hence, these are also said to be Plant Probiotic Bacteria. These plant probiotic microorganisms are beneficial microorganisms that offer a promising alternative and reduce the health problems and constitute an ecofriendly manner to contribute the production of food needed for world population to sustain.

Introduction

The demand for agriculture and food production has been increasing with the growing population globally by the mid-twentieth century to the twenty-first century, the population of the overpopulated areas increased two fold. Between 1960 and 1970, famines threatened many areas around the globe and resulted in many human deaths. To tackle the problem, good agricultural productivity was required, which reduces food insecurity and poverty and also improves human nutrition. This was the origin of the Green Revolution, which appeared between 1966 and 1985.

The set of techniques that made the Green Revolution successful was the genetic improvement of major crops, selecting best genetic traits in order to increase productivity, adaptation to different environments, resistance to harmful abiotic factors, resistance to biotic stress, and reduced harvest periods. The use of these new hybrids increased their yield per hectare. Genetic breeding was not the only factor in the Green Revolution; improvements in the irrigation, cultivation methods, sowing/ harvesting timings, the application of chemical fertilizers, and weed/pest control must be also considered.

Despite the advantages, the Green Revolution had several disadvantages. The extensive farming of monocultures with similar genotypes increased the problem of pests and diseases, which also degenerated with the use of pesticides. Another problem was the disproportional use of chemical fertilizers. Some fertilizers and pesticides, especially when are improperly used, can affect human health and pollute groundwater, causing consequent effects on aquatic systems and the loss of genetic diversity (Conway and Barbie, 1988). Also, the enormous amount of energy and water needed for their synthesis contribute to the depletion of natural resources, as well as to the global warming.

New Green Revolution

By the year 2050, food production should be duplicated, meaning an increase of 2.4% per year; however, at this moment that level is well below (1.3%) (Araus *et al*., 2014). In other words, the population is growing faster than food is produced. To make matters worse, currently, 15% of the population (868 million people) suffers malnutrition. Ideally, production increase should be achieved with less land, less water, less labor, and fewer chemical products. The goal is to obtain high-yield crops that are more resistant to biotic and abiotic stresses. Therefore, the scientific community should develop further research in order to increase crop production and try to completely avoid the previously presented problems.

Plant Probiotics

Plant probiotics are microbial culture which has biocontrol potential and promote plant growth by virtue of their typical mechanisms (Garcia *et al*., 2017). Plant growth-promoting bacteria have different types of associations with plant roots. Based on the relationship of the bacteria with plant, these are classified as Endophytic, Symbiotic, Associative, Free living. Some of them are common rhizosphere inhabitants (PGPR: plant growth-promoting rhizobacteria). Some others live as epiphytes over plant tissues or even inside their plant host, as endophytes, without inducing any disease. In some cases, as in the rhizobia-legume symbiosis, the bacteria live inside nodules - plant organs specifically created for accommodating their microsymbionts (Amara and Shibl, 2015).

Mode of Action

Probiotic bacteria have plant growth promoting ability through a wide range of mechanisms, which can be categorized based on their way of action in: (i) the synthesis of substances that can be assimilated directly by plants; (ii) the nutrient mobilization; (iii) the induction of plant stress resistance; (iv) the plant disease prevention. The microbial interfaces with plants are divided into different classes based on the site and mode of interaction.

Plant probiotics has been gaining the attention conceptually. Plant probiotics are microbial culture which has biocontrol potential and promote plant growth by virtue of their typical mechanisms comprising nitrogen fixation, phosphate solubilization, siderophore production, phytoharmone synthesis and upgraded plant invulnerability in contradiction of various diseases (Ramakrishnan *et al*., 2012). These also enhances the soil structure by amalgamating the soil units together by releasing some extracellular metabolites, promoting the cessation of composite materials and insoluble nutrients into simpler molecules so that it can be easily available for plant growth, these probiotic bacteria provides biocontrol activity by antibiotic production, enzyme production and in turn activates systemic resistance in turn provide resistance against stress and diseases. It is assumed that ample populations of useful soil microbes are mandatory for good soil structure and also provide better plant development. Microbes mainly bacteria that facilitate phosphate solubilization, nitrification and bio-control of plant diseases are the ample examples of plant probiotics. Apart from these rhizobacteria, the findings on endophytic bacteria and fungi showed that bacteria existing in the core background help the plants in nutrient attainment, overall growth and stress tolerance. Thus, the introduction of plant probiotics for promoting plant health, development and better potentiality is an eco-friendly substitute to inorganic fertilizers which sustain soil health as well as encourage organic farming. Results achieved through broad studies have shown that microbes are an important constituent for plant growth and can also increase resistance, tolerance and suppleness of plants in biotic and abiotic stress conditions.

Conclusion

Combinations of one or several of these bacteria are formulated into products and applied to the fields as biofertilizers increasing crop yields by the availability and uptake of mineral nutrients for plants, without a total dependence on chemical fertilizers and, therefore, protecting the environment. Probiotics use has shown many health benefits to plants by increasing the productivity and acting as a biocontrol agent against phytopathogen. Hence it is time to begin a New Green Revolution that will use the advantages of certain microorganisms, the so-called plant probiotics, have on crop development and production and protection.

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