PGPR Secondary Metabolites for Enhanced Plant Protection against Phyto-Pathogens- A Review Paper

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I INTRODUCTION

Plants are constantly exposed to a myriad of potential threats from pathogens such as bacteria, fungi, and viruses. Plant pathogens which cause diseases in plants result in reduction in plant yield; hence bio-control agents are helpful to enhance the plant growth promotion activities by controlling the plant diseases. Through bio-control microbes control the plant pathogen by secreting some specific type of secondary metabolites. To defend themselves, plants have evolved intricate defense mechanisms, including the production of secondary metabolites. These secondary metabolites play a crucial role in protecting plants from harmful pathogens. In recent years, there has been growing interest in harnessing the potential of Plant Growth-Promoting Rhizobacteria (PGPR) to stimulate the production of secondary metabolites in plants, thereby enhancing their resistance to pathogens. Plant rhizosphere is considered as the hot spot for the specific beneficial microbial colonization and proliferation due to the presence of the nutrient rich exudates (Renella et al., 2005). Due to the eco-friendly nature, use of theses microbes does not have any side effect on the environment and human health besides the PGPR have cost effective application in agriculture field. This article explores the fascinating relationship between PGPR and secondary metabolites and their impact on plant protection.

II SECONDARY METABOLITES

Secondary metabolites, also known as phytochemicals, are organic compounds that are not directly involved in the plant's growth, development, or reproduction. Instead, they serve various ecological functions, including defense against herbivores and pathogens. These compounds can be broadly classified into several groups, such as **alkaloids, terpenoids, phenolic** compounds, and **flavonoids.** They play a significant role in plant defense by inhibiting pathogen growth, deterring herbivores, and attracting beneficial organisms.

III THE ROLE OF PGPR

PGPR are beneficial soil bacteria that establish a symbiotic relationship with plants, particularly in the root zone. These bacteria offer several advantages to plants, including enhanced nutrient uptake, stress tolerance, and protection against pathogens. One of the intriguing aspects of PGPR-plant interactions is their ability to stimulate the production of secondary metabolites in plants.

IV PROCESS OF PGPR TO INDUCE SECONDARY METABOLITE PRODUCTION

(a) **Hormonal Regulation:** PGPR can produce plant hormones like auxins, cytokinins, and gibberellins, which regulate various plant processes, including secondary metabolite production. These hormones can signal the plant to increase the synthesis of specific secondary metabolites involved in defense.
(b) **Induced Systemic Resistance (ISR):** PGPR can trigger ISR in plants, a defense mechanism that enhances the plant's resistance against pathogens. ISR involves the activation of defense-related genes and the production of secondary metabolites, such as phenolic compounds and alkaloids.
(c) **Enhanced Nutrient Uptake:** PGPR improve nutrient uptake in plants, which can indirectly influence secondary metabolite production. Nutrient availability plays a critical role in secondary metabolite biosynthesis, and improved nutrient uptake can lead to increased secondary metabolite levels.

V IMPACT OF SECONDARY METABOLITES ON PLANT PROTECTION

The induction of secondary metabolite production in plants by PGPR can significantly enhance plant protection against harmful pathogens. When plants produce higher levels of secondary metabolites, they are better equipped to fend off attacks from various pathogens. Some of the key benefits include:

(a) **Reduced Disease Severity:** Elevated levels of secondary metabolites act as natural antifungal, antibacterial, and antiviral agents, reducing the severity of diseases caused by these pathogens.
(b) **Insect Deterrence:** Secondary metabolites can deter herbivorous insects, minimizing damage to plants and the transmission of diseases carried by insects.
(c) **Enhanced Resistance:** Plants with higher secondary metabolite levels exhibit increased resistance to a wide range of pathogens, making them more resilient in challenging environments.

(d) Environmental Sustainability: The use of PGPR to enhance secondary metabolite production in plants offers an eco-friendly approach to disease management, reducing the reliance on chemical pesticides.

VI CONCLUSION

The interaction between PGPR and secondary metabolites in plants presents a promising avenue for improving plant protection against harmful pathogens. By stimulating the production of secondary metabolites, PGPR can help plants develop a robust defense system that is both effective and environmentally sustainable. Further research into the mechanisms underlying this interaction and its practical applications in agriculture holds great potential for enhancing crop yield and reducing the impact of plant diseases on global food security.

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