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Bacterial Endophytes: The Invisible army of Plant System

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Introduction

Endophytes, usually the bacteria or fungus that resides within the plant system and forms a microenvironment, supporting their growth and development. They exhibit a symbiotic relationship with the host plant. These endophytes get the nutrient-enriched intracellular environment as their site of multiplication and directly benefit plants by stimulating their growth and/ or indirectly protecting against the diseases. Recent studies suggest their role in aiding tolerance to plants against abiotic as well as biotic stresses. Therefore, an increasing effort is being made to utilize endophytes as biological control agents (BCAs) for crop improvement.

Role of Endophytes in plant development

The emergence of the concept "Plant Microbiome", has changed the scenario and thus the coevolution of symbiont and their host plant has tracked the benefits out of their existence. Endophytes may directly or indirectly enhance the plant's growth, development, yield as well as tolerance against diseases and abiotic or biotic stresses.

Direct Mechanism

Direct mechanism involves the production of certain phytohormones, solubilizing inorganic phosphate or biologically fixing nitrogen, etc., that directly ascertains plant's development.

Phytohormone Production

Phytohormones are the key compounds in the growth and development of plants. Numerous bacteria and fungi are there that produces plant growth regulators (PGRs) *viz.*, auxin,

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gibberellin, cytokinin, abscisic acid (ABA), and ethylene. Of these PGRs auxin indole acetic acid (IAA) are the most common ones to be produced by endophytes. Auxin is known for the apical dominance, cell elongation, root initiation, and phototropism in plants. Root initiation and abundance of root hairs help the plants to absorb more of the water and nutrients from soil. Also, the roots provide more sites for infection and nodulation in the case of legume plants.

Biological Nitrogen Fixation

A unique feature exhibited by endophytes is that some bacterial genera are capable of fixing biological nitrogen in a similar way as of rhizospheric bacteria. The development of endophytic bacteria provides a means to improve crop yield and can substitute the chemical requirement of nitrogen. These microbes are termed as diazotrophs and are majorly found in rice, sweet potato, maize, sugarcane, etc.

Phosphate Solubilization

Phosphate are classified as macronutrients and are vital for plant growth. Inorganic phosphate is not directly absorbed by the plants and is required to be solubilized. Endophytic bacteria releasing organic acids into the soil solubilizes the phosphate, converting them into ortho-phosphate that is readily available for absorption. These live microbial biofertilizers can prove a promising substitute for today's chemical fertilizers.

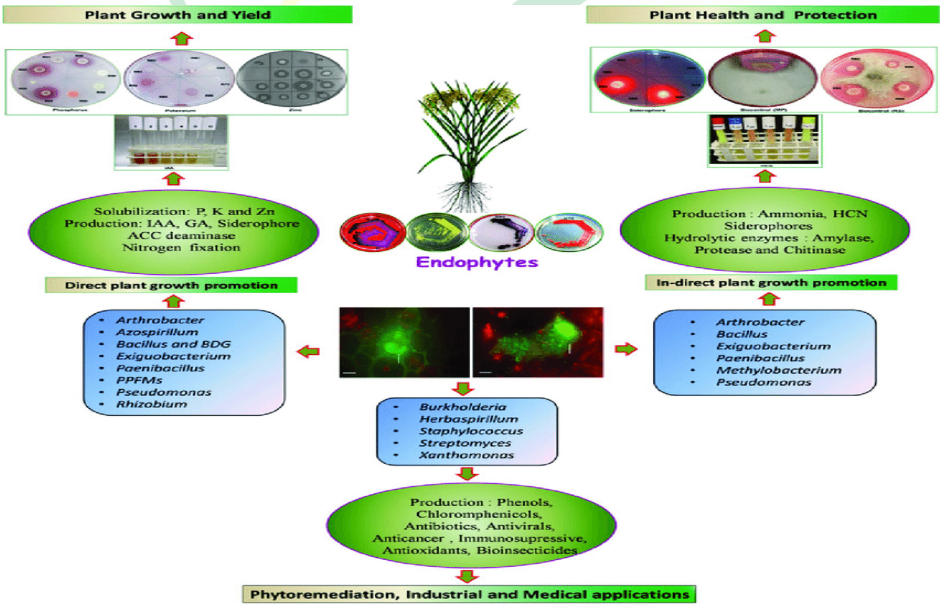

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Fig. 1: Schematic diagram of plant endophytic interaction and their application

Indirect Mechanism

Indirect mechanisms supporting the plant's growth include the protection against the diseases, tolerance towards the abiotic and biotic stresses, production of secondary metabolites, etc.

Tolerance against abiotic stresses

Abiotic stresses continue to be a major threat to crop production. Depending upon the environmental impact these include heat stress, salinity stress, drought stress, cold stress, etc. Endophytes have paved a way as an alternative strategy for the plant's survival during the stresses. Studies suggest, these endophytes colonize in the plant's root and shows effective tolerance against abiotic stresses by modifying the metabolic pathways. They produce enzymes like, peroxidases, heat shock proteins, phosphotransferases, etc., that directly or indirectly helps in the signaling pathways to combat these stresses.

Secondary Metabolite Production

Secondary metabolites are the compound produced by plants that protect them against diseases, stresses, or grazers, etc., Several endophytes also produce these secondary metabolites that aids in plant defense. Reactive oxygen species (ROS) are produced as a signal during environmental stress and interact with metabolites resulting in necrosis and cellular anomalies. These endophytes produce antioxidants in response to these ROS to maintain cellular integrity. Additionally, it has been found that maytansinoid d, an anti-tumor compound that earlier was thought to be obtained from plants is actually of microbial origin.

Conclusion

Endophytes dwelling within the host plants can actually occupy a prominent space in agriculture as well as the medicinal area in coming future. Being able to biologically fix the atmospheric nitrogen and solubilize inorganic phosphate, these microbial biofertilizers can substitute the chemical fertilizers. More research is yet to be done at the genomic aspect so that it can be helpful in crop improvement.

References

Fan, D., Subramanian, S., and Smith, D.L. (2020). Plant endophytes promote growth and alleviate salt stress in *Arabidopsis thaliana*. *Scientific Report Natureresearch* **10:** 12740

Ozbe, AA., Finney, JF. and Staden, JV. (2020). The role of endophytes in secondary metabolites accumulation in medicinal plant under abiotic stresses. *South African Journal of Botany*

Patle, PN., Navnage, NP. and Ramteke, PR. (2018). Endophytes in plant system: Roles in growth promotion, mechanism, and their potentiality in achieving agriculture sustainability. *International Journal of Chemical Studies* **6** (1): 270-274

Suman, A., Yadav, AN. and Verma, P. (2016). Endophytic microbes in crops: Diversity and beneficial impact for sustainable agriculture. *Microbial Inoculants in Sustainable agricultural productivity, Volume **1:*** 117-143

Yadav, A. and Yadav, K. (2017). Exploring the potential of endophytes in agriculture: A minireview. *Advances in Plants & Agriculture research* **6:** 102-106