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PGPR: Revolutionary creations for sustainability

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The micro-organisms with the aim of improving nutrients availability for plants is an important practice and necessary for agriculture. During the past couple of decades, plant growth-promoting rhizobacteria (PGPR) will begin to replace the use of chemicals in agriculture, horticulture, silviculture, and environmental cleanup strategies. Scientific researches involve multidisciplinary approaches to understand adaptation of PGPR, effects on plant physiology and growth, induced systemic resistance, biocontrol of plant pathogens and biofertilization. This is due to the emerging demand for dependence diminishing of synthetic chemical products, to the growing necessity of sustainable agriculture within a holistic vision of development and to focalize environmental protection. The PGPR are naturally occurring soil bacteria that aggressively colonize plant roots and benefit plants by providing growth promotion.

The rhizosphere is a nutrient-rich habitat and harbors a huge variety of bacteria and fungi that each can have neutral, beneficial or deleterious effects on the plant. Some of these organisms can improve plant growth by different mechanisms. Fluorescent *Pseudomonas* and *Trichoderma species* are important groups of plant growth-promoting micro-organism reported to protect plants against pathogens by evolving various mechanisms such as antagonism, competition and Induced systemic resistance (ISR). Rhizosphere colonization by certain PGPR and plant growth-promoting fungi (PGPF) can elicit ISR. Induced systemic resistance (ISR) triggered by plant growth-promoting fungi (PGPFs) and Plant growth promoting rhizobacteria (PGPR) confers a broad-spectrum resistance that is effective against different types of pathogens.

Role of PGPR : The Plant growth promoting rhizobacteria, compost and chemical fertilizers significantly affect the growth and yield of different crops. A novel approach could be that composted material may be converted into a value added product such as an effective biofertilizer by blending with PGPR which are free living soil bacteria that can either directly or indirectly facilitate rooting and growth of plants. There are several mechanisms by which PGPR effect plant growth such as ability to produce various compounds (phytohormones, organic acids, siderophores), fix atmospheric nitrogen, solubilize phosphate and produce antibiotics that suppress deleterious rhizobacteria, and production of biologically active substances or plant growth regulators (PGRs) is one of the major mechanisms through which PGPR influence the plant growth and development. Plant growth promoting rhizobacteria, having multiple activities directed toward plant growth promotion *vis-a-vis* exhibiting bioremediating potentials by detoxifying pollutants like, heavy metals and pesticides and controlling a range of phytopathogens as biopesticides, have shown spectacular results in different crop plants has been observed following PGPR applications. The productive efficiency of a specific PGPR may be further enhanced with the optimization and acclimatization according to the prevailing soil conditions.

PGPR as a Biofertilizer : The plant-PGPR cooperation plays a major role by enhancing growth and health of widely diverse plants. That plant PGPR independently produced IAA has also been revealed. It is obviously a step forward in our understanding of plant-PGPR co-operation but it does not fully clarify the bacterial functions and plant hormonal networks involved in components of hormonal pathways. Phytohormone-producing *Bacillus* sp., WhIr-15 and *B. subtilis* WhIr-12, isolated in the present study, have potential at field level to improve wheat productivity and may be helpful in the formulation of an effective biofertilizer for wheat. Expected to replace the chemical fertilizers, pesticides and artificial growth regulators which have numerous side effects to sustainable agriculture. Multifaceted bacterium of *Bacillus amyloliquefaciens* was improved growth, yield and nutrition of soybean through the contributions of the bacteria mediated induced mechanisms/ processes in the rhizosphere of the soybean and also as a broad-spectrum bioinoculant for soybean cultivation in India.

PGPR as a Biocontrol : The plant growth-promoting traits by a comparative genomics analysis of four

representative pseudomonad PGPR strains. The genes that were conserved among the different Pseudomonas species have provided clues to the common characteristics of pseudomonad PGPR, such as rhizosphere competence traits (nutrient catabolism and transport, resistance to various environmental stresses and rhizosphere colonization). Recently reported genome of *P. chlororaphis*, together with other sequenced strains of different species of pseudomonad PGPR, provides insights into the genetic basis of diversity and adaptation to specific environmental niches. Genetic modification may accelerate the commercialization of PGPR as biocontrol agents, which could further contribute to sustainable development of agriculture. The ability of bacterial siderophores and antibiotics to suppress.

PGPR as a bioformulation : The new challenge in the new millennium is to produce more and more food from shrinking per capita arable land, keeping the environment safe. As agricultural production intensified over the past few decades, producers became more and more dependent on agrochemicals. Chemical fertilizers and pesticides are presently accumulating in the environment harming the ecosystem, causing pollution and spreading disease. Therefore, the urgent need of biological agents is accepted worldwide. Interest in biological control of plant pathogens has increased considerably over the past years, partly as a response to public concern about the use of hazardous chemical pesticides, but also because it may provide control of diseases that cannot or only partially be managed by other control strategies.

The plant growth promoting phenomenon can be attributed to the ability of the isolate to produce IAA, as IAA positively influences root growth and development, thereby enhancing nutrient uptake. It is a well-established fact that improved phosphorus nutrition influences overall plant growth and root development. Plant microbe interaction in Rhizosphere must increase before we can presume that utilization of PGPR as biofertilizers will determine a sustainable promotion of host plants growth. Combinations of beneficial bacterial strains that interact synergistically are currently being devised and numerous recent studies have shown a promising trend in the field of inoculation technology. PGPR are excellent model systems which can provide biotechnologist with novel genetic constituents and bioactive chemicals having diverse uses in agriculture and environmental sustainability

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