

## Use of plant growth–promoting rhizobacteria (PGPR) in stressed agriculture management

Enhanced incidence of abiotic stresses influencing adversely plant growth and productivity in major crops, and thus global food security, is being witnessed all over the world. These abiotic stress factors include drought (water deficit) and flooding, salinity, nutritional imbalance, high and low temperature, heavy metals toxicity, UV radiation, light, chemical pollutants, etc. Moreover, climate change is also helping worsen the frequency and severity of many abiotic stresses, especially high temperatures and drought. It has been reported that these stresses affect about 96.5% of arable land worldwide. Whereas, plants that are stress–resistant can produce significant yields in the stress–affected agricultural environments, many agricultural crops exhibit a low tolerance to these stresses. Future agricultural production to feed all of the world’s population in these stress–affected agricultural environments thus requires the development of stress–tolerant crops.

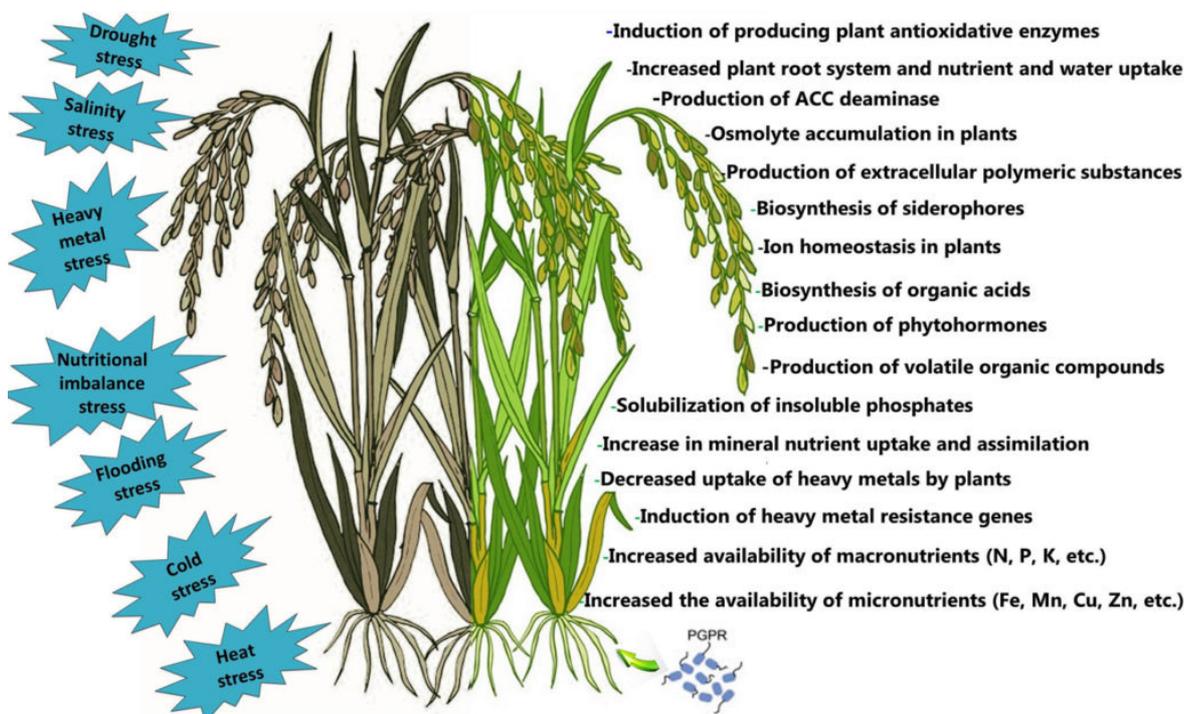


Fig. 1. Some of action mechanisms of PGPR in alleviating abiotic stresses in plants.

Traditional breeding and genetic engineering approaches have had only limited successes in developing various stresses-resistant plants, despite significant efforts. In addition, because of many hindrances such as limitations in DNA recombinant technology in some regions of the world and proprietary rights and international trade agreements on genetically modified crops, genetic modification of all plant species is not possible. Under such stressful conditions, the role of interactions of plant and beneficial microorganisms is of great significance. Use of microorganisms that increase crop growth is known as an alternative strategy to

environmental stresses–sensitive crops improvement to enhance stress tolerance. Among the microorganisms associated with plants, plant growth–promoting rhizobacteria (PGPR) have been effective at improving plant stress tolerance coined the term “Induced Systemic Tolerance” to describe the tolerance to abiotic stresses that is elicited by PGPR in plants. PGPR isolated from stress–affected habitats have been shown to be more efficient at augmenting plant tolerance to environmental stresses than PGPR isolated from non–stress habitats. There is now clear evidence that PGPR associated with plants growing in harsh environmental conditions help those plants tolerate abiotic stresses. These PGPR increase plant growth and resistance to various abiotic stresses (Fig. 1) by various mechanisms (more than one mechanism of action) such as (i) production of 1–aminocyclopropane–1–carboxylate (ACC) deaminase, reducing production of “stress ethylene”; (ii) modifications in phyto–hormonal content; (iii) induction of producing plant anti–oxidative enzymes; (iv) improvement in the uptake of essential mineral elements (i.e., by production of siderophore, potassium and phosphate solubilization, etc.); (v) extracellular polymeric substance (EPS) production; (vi) decrease in the absorption of excess nutrients/heavy metals; and (vii) induction of abiotic stress resistance genes.

Usually, most PGPR associated with plants possessed more than a plant growth promoting trait (i.e., production of IAA, siderophore, and ACC deaminase, phosphate solubilization, etc.). Since some of the abiotic stresses occurred simultaneously, causing the interactions of physiological processes, use of various environmental stresses–tolerant PGPR with multiple plant growth–promoting traits may be a cost effective and environment friendly strategy to alleviate abiotic stresses in various crop plants, ensure sustainable agriculture, and mitigate environmental stress impacts on global food supply. In general, identifying and using various abiotic stresses–tolerant PGPR with multiple plant growth–promoting traits could not only enhance the abiotic stresses tolerance of crop plants but also decrease pressure on arable lands.

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## **Publication**

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