

Rizobacteria: in plants mitigates the water deficit

Abstract

Plant water deficit, causes losses in all stages of development and productivity, plants have mechanisms to minimize the negative effects of this stress, studies with plant growth promoting rhizobacteria (PGPR) are able to act to mitigate damage in plants. plants, by the protection of the photosynthetic apparatus, with an increase in carotenoid concentration, reducing photochemical damage, as well as helping to change the concentration of osmoregulators in plants, such as proline and malonic aldehyde (MDA), and eliminating reactive oxygen species (ROS).

Keywords: PGPR, biochemistry, osmoregulator

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Abbreviations: PGPR, plant growth promoter rhizobacteria; MDA, malonic aldehyde; ROS, reactive oxygen species; ISR, induced defense system; Ci, internal carbon

Introduction

The abiotic stresses (water stress, saline, temperature) in which plants are submitted during their cultivation cycle induce plants to biochemical responses, which act in the induced defense system (ISR). And studies in bioinoculant plants with growth promoting rhizobacteria (PGPR) show that the response to mitigation of damage to abiotic stresses is potentiated by plants.

About 5 to 21% of the internal carbon (Ci) fixed in the leaves is transported to the roots and released into the rhizosphere through root exudation, which together with the exopolysaccharides (released by the PGPR) act in the formation of a biofilm, which aid in attraction and bacterial fixation on the epidermis of the roots, which then penetration and colonization along the root.

Our studies with *Burkholderia pyrrocinia* BRM-32113 and *Pseudomonas fluorescens* BRM-32111, in upland rice plants over water deficit, were able to mitigate the damage caused by the deficit (Figure 1).



Figure 1 Leaf and roots of rice plants, from seeds inoculated with PGPR and subjected to water deficit. Rice plants uninoculated (control) (A), *B. pyrrocinia* BRM-32113 (B) and *P. fluorescens* BRM-32111 (C), in 100 % field capacity (1) and 50 % field capacity (2).

PGPR action on plants in water deficit

PGPRs induce increased production of carotenoids and chlorophyll b (accessory pigments) that absorb photons and transfer excitation energy to reaction centers via chlorophyll, and protect chlorophyll from photo-oxidation, carotenoids also act as antioxidants and against photochemical damage.

The loss of chlorophyll content under water stress is considered one of the main causes of photosynthesis decrease. In addition, the reduction of chlorophyll content can be attributed to loss of chloroplast membranes through the reactions of water-soluble enzymes located in the chloroplast stroma (Calvin cycle) or at the border between stroma and thylakoids (ATP-ase, NO_2^- , and reduction of NADP^+) that are affected by osmotic stress.¹

Induction of accumulation of osmoregulators by prgr

The highest accumulation of proline in plants occurs as a response to water deficit tolerance induced by PGPR, which in plants without PGPR,² as shown in plant studies under stress: water deficit, salinity, low temperature, exposure to heavy metals, UV radiations. Proline is a highly soluble, low molecular weight, organic compound and generally nontoxic at high cell concentrations and acts on cellular osmotic adjustment and detoxification of reactive oxygen species (ROS), protection of membrane integrity, enzymes and stabilization of proteins.³

In membranes and proteins, elimination of free radicals and redox cellular buffer under stress conditions occurs and can also act to alleviate cytoplasmic acidosis and maintain $\text{NADP}^+/\text{NADPH}$ compatible with metabolism. Its accumulation normally occurs in the cytoplasm where it functions as molecular chaperons stabilizing the structure of the proteins and their buffers for cytosolic pH accumulation and maintains the cellular redox state.⁴

The increase in the accumulation of MDA is an indicator of oxidative damage in plants under stress conditions, in plants inoculated with PGPR less accumulation of MDA resulting in the protection

of the membranes, since the high concentration of MDA produced during lipid peroxidation, a strong indicator of cell damage caused to the membrane which acts on decreasing the membrane stability that reflects the extent of lipid peroxidation.

Lipid peroxidation is an indicator of the free radical reaction in tissues, where oxygen uptake in tissues generates reactive oxygen species (ROS), particularly H_2O_2 , which is produced at high rates by the glycolate oxidase in the peroxisomes in photorespiration.⁵

Conclusion

In this way, PGPRs act in the process of mitigating the damages caused by the water deficit in the plants, by maintaining the integrity of enzymes and proteins of cell wall, and in the increase of osmoregulators, acting in the osmotic equilibrium of the system.

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Conflict of interest

The author declares that there is no conflict of interest.

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