Journal of Plant Biochemistry & Physiology
ISSN: 2329-9029
OPEN ACCESS Freely available online
Commentary

Harnessing Plant Growth-Promoting Rhizobacteria for Enhancing Metal and Salt Stress Tolerance in *Brassica juncea*: Insights into Ion Homeostasis

Harish Ponam*

Department of Plant Phytomorphology, Andhra University, Vishakapatnam, India

INTRODUCTION

Metal and salt stress pose significant challenges to plant growth and productivity, particularly in regions with high soil salinity or metal contamination. *Brassica juncea*, a widely cultivated *Brassicaceae* species, faces these challenges in its natural habitat. However, recent research has highlighted the potential of Plant Growth-Promoting Rhizobacteria (PGPR) in mitigating these stresses by modulating ion homeostasis. This article reviews the mechanisms through which PGPR enhance metal and salt stress tolerance in *B. juncea*, focusing on their role in regulating ion homeostasis.

Brassica juncea, commonly known as Indian mustard, is an economically important crop cultivated worldwide for its edible oil and high biomass production. However, its growth and productivity are significantly affected by metal and salt stress, which impair various physiological and biochemical processes. In recent years, the use of PGPR has emerged as a sustainable approach to enhance stress tolerance in plants. This article explores the potential of PGPR in ameliorating metal and salt stress in *B. juncea* by maintaining ion homeostasis.

Mechanisms of metal and salt stress tolerance

Metal and salt stress disrupt ion homeostasis in plants, leading to excessive accumulation of toxic ions such as Na^+, Cl^- and heavy metals. This disturbance triggers oxidative stress, membrane damage and disruption of cellular processes. To counteract these effects, plants employ various mechanisms, including ion exclusion, compartmentalization and detoxification. However, under stress conditions, these mechanisms may be insufficient to maintain ion homeostasis.

Role of PGPR in enhancing stress tolerance

PGPR colonize the rhizosphere of plants and establish beneficial interactions that promote growth and stress tolerance. Several mechanisms have been proposed to explain the ability of PGPR to enhance stress tolerance in plants. These include phytohormone production, induction of systemic resistance and modulation of antioxidant defense systems. Importantly, PGPR play a crucial role in regulating ion homeostasis under stress conditions.

PGPR-mediated regulation of ion homeostasis

PGPR enhance metal and salt stress tolerance in *B. juncea* by modulating ion homeostasis through various mechanisms. One such mechanism involves the secretion of organic acids and siderophores, which chelate toxic ions and facilitate their uptake or sequestration in the rhizosphere. Additionally, PGPR promote the expression of ion transporters and channels involved in ion uptake and compartmentalization, thereby reducing the accumulation of toxic ions in plant tissues.

Furthermore, PGPR induce the synthesis of osmolytes such as proline and glycine betaine, which help maintain cellular osmotic balance and stabilize membranes under stress conditions. Moreover, PGPR-mediated activation of antioxidant enzymes such as superoxide dismutase and catalase scavenges reactive oxygen species generated under stress, thus protecting cellular components from oxidative damage.

CONCLUSION

The utilization of PGPR offers a promising strategy for enhancing metal and salt stress tolerance in *B. juncea* through the regulation of ion homeostasis. By promoting ion uptake, sequestration and detoxification, PGPR help alleviate the detrimental effects of metal and salt stress on plant growth and productivity. Future research should focus on elucidating the specific mechanisms underlying PGPR-mediated ion homeostasis regulation and their application in sustainable agriculture practices aimed at mitigating environmental stresses.

Correspondence to: Harish Ponam, Department of Plant Phytomorphology, Andhra University, Vishakapatnam, India; E-mail: ponam_harish@gmail.com

Received: 04-May-2024, Manuscript No. jpbp-24-31143; **Editor assigned:** 08-May-2024, PreQC No. jpbp-24-31143 (PQ); **Reviewed:** 22-May-2024, QC No. jpbp-24-31143; **Revised:** 04-June-2025, Manuscript No. jpbp-24-31143 (R); **Published:** 11-June-2025, DOI: 10.35248/2329-9029.25.13.356

Citation: Ponam H (2025) Harnessing Plant Growth-Promoting Rhizobacteria for Enhancing Metal and Salt Stress Tolerance in *Brassica juncea*: Insights into Ion Homeostasis. J Plant Biochem Physiol. 13:356.