NEW ERA AGRICULTURE MAGAZINE

Unleashing the Power of Seed Priming: A Game-Changer in Crop Resilience Against Heat Stress

Mahamed Ashiq I[1]*, Chandan A S[2]*, Rakhesh S[3]*, and Basavaraj M Pattanashetti[4]*

Abstract:

In the realm of agriculture, heat stress poses a significant threat to global food security, impacting crop yields and quality worldwide. Seed priming, a cost-effective management strategy, has emerged as a promising solution to enhance crop resilience against the detrimental effects of heat stress. This article explores the concept of seed priming and its effectiveness in inducing stress tolerance mechanisms within plants. Through the application of chemical agents and harnessing microbial interactions, seed priming promotes germination, seedling growth, and physiological adaptations that fortify crops against heat stress and other abiotic stresses. Furthermore, seed priming induces a memory effect within plants, enabling them to withstand subsequent heat stress events. At the molecular level, a complex network of transcription factors, histone modifications, and heat shock proteins orchestrates the plant's response to heat stress priming, highlighting the intricate mechanisms underlying plant resilience. As research in seed priming continues to advance, it offers a beacon of hope for a more sustainable and food-secure future in the face of escalating climate uncertainty.

Introduction:

In the vast tapestry of agricultural challenges, heat stress emerges as a formidable adversary, threatening crop yields and food security worldwide. As temperatures soar, plants experience desiccation, oxidative damage, and protein degradation, culminating in wilting, yield reduction, and even death. In this battle for survival, a revolutionary strategy has emerged: seed priming a cost-effective management solution that holds the key to enhancing crop resilience against the ravages of heat stress. The concept of seed priming is elegantly simple yet profoundly effective. By treating seeds with chemical agents before sowing, farmers can equip plants with the tools they need to withstand heat stress and other abiotic stresses such as salinity and drought. Studies have shown that seed priming promotes stress tolerance by inducing a range of protective mechanisms within the plant, from enhancing germination and seedling

Mahamed Ashiq I[1]*, Chandan A S[2]*, Rakhesh S[3]*, and Basavaraj M Pattanashetti[4]*

[1]Department of Biotechnology, IABT, University of Agricultural Sciences, Dharwad-580005
[2]Department of Crop Physiology, Assam Agricultural University, Jorhat-13, Assam- 785013
[3]Department of Agricultural Entamology, University of Agricultural Sciences, Dharwad-580005
[4]Department of Genetics and Plant Breeding, University of Agricultural Sciences, Dharwad-580005

growth to bolstering photosynthesis and membrane integrity.

Case studies

One of the key players in this biochemical orchestra is salicylic acid, a plant hormone known for its role in stress tolerance mechanisms. Research has demonstrated that pre-treating grapevine seedlings with salicylic acid can mitigate the damaging effects of heat stress, offering a lifeline to crops facing scorching temperatures. Similarly, the application of osmoprotectants like glycine-betaine has been shown to improve seed germination and increase leaf water potential, providing a shield against heat-induced dehydration (Wahid and Shabbir, 2005). But seed priming goes beyond mere chemical treatments, it delves into the realm of microbial interactions, harnessing the power of beneficial bacteria to enhance plant resilience. Biopriming of seeds with rhizobacteria has been shown to increase seed germination rates, seedling uniformity, and ultimately plant yield under heat stress conditions. By forming symbiotic relationships with seeds, these bacteria pave the way for acclimatization to suboptimal conditions, fortifying crops against the onslaught of heat stress.

Yet perhaps the most intriguing aspect of seed priming is its ability to induce memory within plants, a phenomenon that echoes the resilience of memory in the human brain. Exposing plants to sub-lethal heat stress triggers a priming phase, after which distinct heat stress memory remains active for several days. This acquired thermal tolerance is a conserved mechanism across various organisms, highlighting the evolutionary significance of stress adaptation (Mittler et al., 2012).

At the molecular level, a complex interplay of transcription factors, histone modifications, and heat shock proteins orchestrates the plant's response to heat stress priming. Heat shock transcription factors govern the expression of genes involved in stress response, while specific histone and chromatin modification genes regulate the establishment of heat stress memory. Meanwhile, at the protein level, heat shock proteins with chaperone activities safeguard the integrity of cellular structures, ensuring the plant's survival under stress (Ohama et al., 2017). Furthermore, emerging research suggests that small RNAs and alternative splicing mechanisms play pivotal roles in establishing and perpetuating heat stress memory in plants. These molecular players not only mediate stress response but also contribute to plant growth, development, and differentiation under adverse conditions, highlighting the intricate web of interactions that underpin plant resilience.

Conclusion

In conclusion, seed priming stands as a transformative strategy in combating heat stress, a pervasive threat to global food security. Through pre-sowing treatments with chemical agents and harnessing microbial interactions, seed priming enhances plant resilience against heat stress and other abiotic challenges, as evidenced by case studies showcasing the effectiveness of salicylic acid, osmoprotectants, and rhizobacteria. The induction of memory within plants underscores the adaptive potential of seed priming, driven by a complex interplay of molecular mechanisms. As we delve deeper into understanding these processes, seed priming offers hope for a sustainable future in agriculture, ensuring crops thrive amidst the uncertainties of climate change and bolstering food security for generations to come.

References

1. Wahid, A. and Shabbir, A., 2005. Induction of heat stress tolerance in barley seedlings by pre-sowing seed treatment with glycinebetaine. Plant Growth Regulation, 46, pp.133-141.
2. Mittler, R., Finka, A. and Goloubinoff, P., 2012. How do plants feel the heat?. Trends in biochemical sciences, 37(3), pp.118-125.
3. Ohama, N., Sato, H., Shinozaki, K. and Yamaguchi-Shinozaki, K., 2017. Transcriptional regulatory network of plant heat stress response. Trends in plant science, 22(1), pp.53-65.