

Salicylic Acid: Enhanced Heat Resilience in Plants

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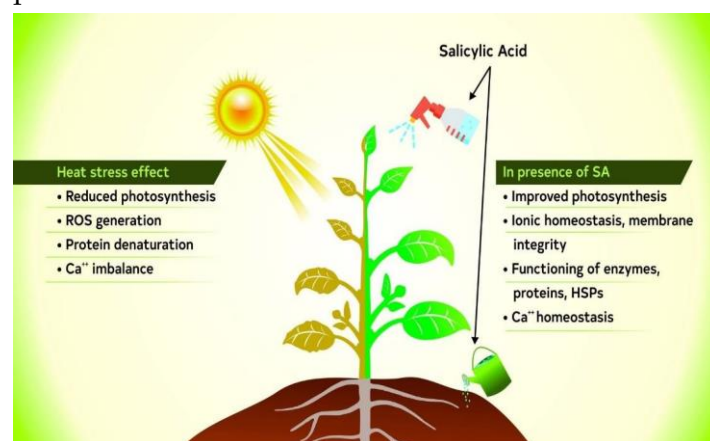
Among the ever-shifting environmental dynamics, the steadily increasing surrounding temperature stands out as one of the most detrimental stressors constantly changing environmental conditions, the gradually rising ambient temperature is one of the most harmful stress. Both scientists and governments are expressing apprehension over this temperatures escalation due to its direct and indirect repercussions on the planet's biodiversity. Heat stress affect plants in a variety of ways including membrane integrity and protein, altering nucleic acid and protein metabolism, destroying membrane structure and lowering photosynthesis. Heat stress causes excessive water loss from plant tissues by accelerating the rate of transpiration. It can cause dehydration, wilting and eventually plant death. When plants are subjected to high-temperature conditions they frequently increase the production of salicylic acid as part of their stress response.

Some of the ways in which Salicylic acid-enhanced heat resilience in plants include:

- Heat shock proteins
- ROS signaling
- Antioxidant defense system
- Photosynthesis efficiency
- Membrane stability and fluidity
- Transcriptional regulation

Salicylic acid (SA) is a crucial component of the signaling pathways for abiotic and biotic defense responses. It is a naturally occurring plant hormone and a key signaling molecule involved in the plant's defense systems against a variety of stresses including heat stress. Salicylic acid-enhanced heat resilience in plants is a phenomenon in which SA plays a crucial role in improving plants' ability to withstand and cope with heat stress. By employing various mechanisms such as the removal of reactive oxygen species (ROS), heightened synthesis of heat shock protein (HSPs), improved photosynthetic efficiency and safeguarding of the reproductive system, topical application confers heat stress

resistance upon plants. The effectiveness of SA on plants is influenced by factors like concentration, plants species and maturity, specific treated tissues and the duration of the treatment. protection, it gives heat stress resistance to the plants when applied topically. The concentration used, plant species and age, kind of tissues treated, and length of treatment are all the factors that affect how SA affects plants.



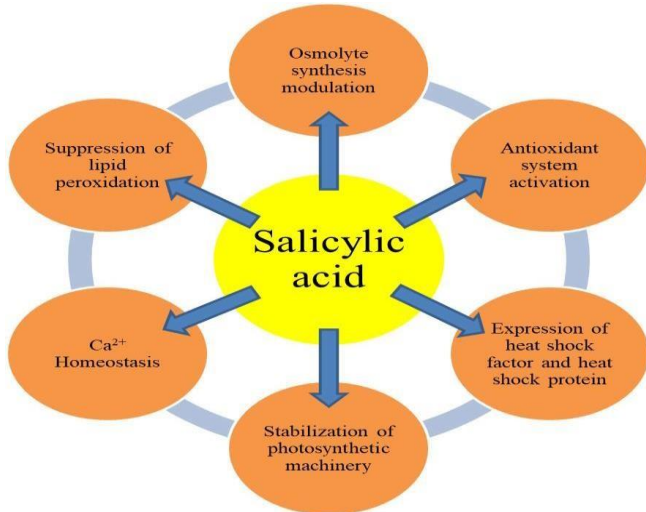
Source (Sangwan *et al.*, 2022)

Heat shock proteins (HSPs)

SA induces the expression of the heat shock proteins also known as molecular chaperones that assist plants in maintaining proper protein folding and protecting them from heat-induced damage. They serve to protect cells from damage and ensure that important cellular functions remain to function properly. HSPs also help in the protection and repair of photosynthetic proteins to maintain photosynthetic efficiency.

ROS scavenging and Antioxidant system

Salicylic acid stimulates antioxidant defense systems, which can neutralize reactive oxygen species (ROS) created under heat stress. ROS are toxic byproducts of cellular metabolism that can cause oxidative damage to plant cells.



Source (Sangwan *et al.*, 2022)

Photosynthesis efficiency: Salicylic acid plays a role in shielding the photosynthetic machinery against heat-triggered harm, thus upholding optimal photosynthetic efficiency and carbon assimilation in elevated temperature conditions.

Ca²⁺ homeostasis: Salicylic acid (SA) has the capacity to uphold the balance of calcium ions (Ca²⁺) within the leaves. The elevation of cytoplasmic Ca²⁺ levels due to prior SA treatment could potentially contribute to the preservation of plasma membrane integrity, thereby bolstering the plant's ability to withstand stress.

Conclusion and future perspectives: The impact of heat stress adversely affects both the vegetative and reproductive aspects of virtually all

plant species. To mitigate the detrimental consequences of heat stress, the application of various plant growth regulators is imperative.

The important role of SA in improving the tolerance against heat in the plants can have significant effects for sustainable agriculture particularly in the face of rising temperatures caused by climate change. Because of its crucial role in the plant defense systems and also stress responses, this is an interesting target for researchers in search of ways to improve crop resilience.

Among these regulators, salicylic acid (SA) has garnered increasing popularity in the realm of heat stress mitigation techniques. SA's efficacy is popularly notable when administered as a foliar spray. This treatment leads to notable enhancements in key parameters including photosynthetic metrics,

relative water content, chlorophyll content, membrane stability index and heat susceptibility index.

However, the precise mechanisms through which SA operates in the context of heat stress signaling - how it targets are perceived, transduced and coordinated - remain an enigma. To unravel these complexities, an interdisciplinary approach encompassing molecular biology, genetics, computational biology, genomics, bioinformatics, biochemistry and metabolomics holds promise for further elucidating these processes.
