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Abscisic Acid: The Unsung Hero of Plant Survival

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Abscisic acid is an important phytohormone released in plants, which is also called stress hormone because of its important role in mitigating the abiotic stress conditions. It also controls the opening and closing of the stomata for maintaining the water balance. It also plays a major role in inducing the seed dormancy to prevent the effect of unfavorable environmental conditions on the seedling. It also involves allocating the resources to different parts of the plant during the stress condition for the survival of the plant (Chen et al., 2020).

Potential roles of ABA in plants

Abscisic acid, known as ABA, plays a pivotal role as the most significant phytohormone responsible for enhancing abiotic stress tolerance in crop plants. During stressful conditions such as drought, extreme temperatures, and high salinity, the ABA content in plants significantly rises, inducing stress-tolerance effects that aid plants in adapting and surviving these challenging circumstances. It carries out various functions in plants, with the following being among its primary functions.

1. **Seed dormancy and germination:** The seed is a reproductive body, and it is embryonic stage of plant's life in higher plants, and the process of seed dormancy and germination represents a significant stage in the plant's life cycle, holding vital ecological and economic importance. Two hormones, ABA and gibberellins (GAs), play a crucial role in regulating the mechanisms of seed dormancy and germination. Both ABA and GAs are responsible for maintaining the balance between seed dormancy and germination. ABA plays a pivotal role in initiating and sustaining seed dormancy while also inhibiting the transition from the embryonic to germination growth phase (Sano et al., 2021).
2. **Structural modification of the root:** In roots, three primary factors influence their structure: the positioning of lateral roots, the angle they form with the parent root, and their length. Root architecture is shaped through interactions between roots and their environment over time. ABA (abscisic acid) plays a significant role in altering root architecture, thereby affecting the growth and quiescence patterns in plant roots. Consequently, alterations in the root environment have both local and systemic effects on ABA-mediated responses. ABA also plays a crucial role in mitigating drought, salt, and osmotic stress, where all three stresses lead to reduced soil water potential, with salt stress introducing ionic stress as an additional component (Kim et al., 2022).
3. **Regulation of stomatal functioning:** Stomata, which are small pores on leaf surfaces regulated by guard cells, play a vital role in plant gas exchange. Normally, light promotes stomatal

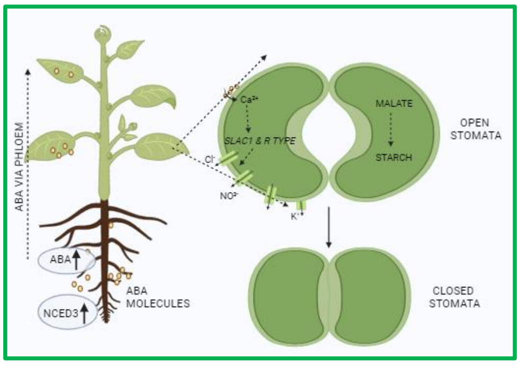

Fig 1. ABA mediated stomatal closure under drought stress

opening, while ABA and elevated CO2 levels cause them partially or completely to close. When stomata close, gas exchange decreases, leading to reduced photosynthate production, and transpiration is reduced, preventing water loss from leaves. During drought conditions, ABA alters guard cell ion transport, promoting stomatal closure and reducing water loss (Liu et al., 2022) (Fig 1.)

4. **Decoding the Senescence Pathway:** Leaf senescence, a vital stage of plant development, is influenced by a range of factors, including ABA (abscisic acid). The increase in endogenous ABA levels correlates with leaf senescence and induces the expression of senescence-associated genes. NAC-type transcription factors, particularly AtNAP and OsNAP, play essential roles in ABA-mediated leaf senescence. These findings emphasize the importance of ABA and NAC-type factors in regulating this natural process (Luo et al., 2021).

Abscisic acid (ABA) orchestrating crucial processes such as stress responses, seed dormancy, growth inhibition, and senescence serves as a master regulator. It's multifaceted roles ensure plants can adapt to environmental challenges, optimize resource use, and maintain overall health and productivity.

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