

Decoding Auxin Mediated Guard Cell Signaling Mechanisms for Drought Tolerance in Plants

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The global human population is predicted to reach 10 billion by 2025. In order to sustain such a huge population, we need to improve our agricultural practices. Abiotic stresses such as drought, heat, and salinity impact plant growth and yield negatively. This challenge is magnified by urbanization and loss of arable land (Hamann et al., 2021). The United States Department of Agriculture projects that worldwide crop production needs to increase to between 14-15 trillion calories to adequately feed the population (a 47-61% increase from 2011 crop production). Enhancing crop yield and stress tolerance is therefore urgent. Plant responses to abiotic stress(es) are regulated by complex interactions between hormones, metabolites, and pathways. Among these, abscisic acid (ABA), auxin, calcium, and receptor-like kinases emerged as critical regulators of abiotic stress responses (Gonzales and Kelley 2025; Salehin 2024; Waadt et al., 2024; Jing et al., 2023; 2023; Weijers & Wagner 2016; Takahashi et al., 2018; Salehin and Estelle, 2015). However, despite decades of research, challenges remain on how the stress adaptation happens at the systems level.

Plants conserve water during drought by closing tiny pores on their leaves, called stomata. Stomata are made with a pair of guard cells. Our newly established lab is trying to understand how a plant hormone, auxin, helps to regulate the closure and opening of stomata to protect plants during drought. Auxin is a major growth hormone, and auxin signaling is mediated by the degradation of AUX/IAA proteins by TIR1/AFB F-box E3 ligases (Salehin et al., 2015). We report an integrated framework for auxin-mediated guard cell signaling that underlies drought adaptation in *Arabidopsis thaliana*. We demonstrate that drought induces guard cell-specific accumulation of Aux/IAA19 and an Aux/IAA19-WRKY63-MYB28/29 transcriptional module upregulates aliphatic glucosinolates (A-GLS) biosynthesis. Genetic and physiological analyses reveals TIR1/AFB-Aux/IAA auxin co-receptors and many A-ARFs act antagonistically with abscisic acid (ABA) to fine-tune GC dynamics in a concentration- and tissue-dependent manner (Salehin *et al unpublished.*, Salehin *et al.*, 2019; Takahashi *et al.*, 2018; Shani and Salehin *et al.*, 2017). Our findings using calcium, reactive oxygen species (ROS), and auxin biosensors further demonstrate rapid Ca^{2+} and ROS signatures in guard cells triggered by A-GLS, and auxin, independent of ABA to regulate stomatal dynamics. These findings are linked to the overarching goals of understanding and translating abiotic stress tolerance to economic crops in our lab using genomic tools (Haghani et al., 2026).

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