How plants sense the continuing CO_2 increase to narrow stomatal pores and regulate water loss

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Stomatal pores in plants control CO_2 influx and water loss. Respiration in the dark and atmospheric [CO_2] elevation cause an increase in leaf CO_2 (C_i), causing reduction in stomatal pore apertures. CO_2-induced reduction in stomatal conductance could enhance water use efficiency of plants. However, the underlying CO_2 sensing mechanisms remain unknown.

Research has suggested that bicarbonate (HCO_3^-) may directly up-regulate SLAC1 anion-channels, which is required for stomatal closing. However, whether this HCO_3^- regulation is relevant remained unknown. We computationally predicted candidate bicarbonate-binding sites in SLAC1 through molecular dynamics simulations. Gas exchange and patch-clamp experiments with complemented *slac1* mutant plants expressing SLAC1 proteins mutated at a critical site for HCO_3^- regulation suggest that SLAC1 can function as a direct “secondary” bicarbonate/CO_2 sensor. An additional primary CO_2 sensor is needed for protein kinase activation.

[CO_2] elevation and the plant hormone abscisic acid (ABA) trigger stomatal closure. However, it remains unclear whether [CO_2]-triggered stomatal closure is mediated via activation of ABA signaling. Data using multiple approaches including newly designed real-time FRET protein kinase-nanosensors and ABA-nanosensors provide evidence for a new model of how CO_2 signaling and ABA signaling merge in stomatal control.

Advances at dissecting CO_2-specific signaling in the grass species *Brachypodium distachyon* will be presented. A new critical component that functions in transmitting osmotic/drought stress and abscisic acid signal transduction will be presented, leading to a new model for early ABA signal transduction mechanisms that control stomatal movements.