(SD2020-397) Identification of the plant stomatal CO_2 sensor and uses thereof

Tech ID: 33201 / UC Case 2021-Z08-1

ABSTRACT

Drs. Schroeder and Takahashi of UC San Diego have discovered and characterized a stomatal CO2 sensor and the underlying mechanism in plants. This unique plant CO2 sensor shows very strong phenotypes in mutants, with complete lack of a CO2 response. Moreover, the researchers can reconstitute this CO2 sensor with the recombinant protein complex in vitro. They are using this discovery to further develop genetic applications to modify CO2 sensing and water use efficiency in plants. The researchers have identified two protein kinases, which regulate a Raf-like protein kinase which in turn controls another Raf-like kinase activity in response to change in CO2/bicarbonate concentration in vitro. Mutants in each of these proteins completely disrupt CO2 responses in plants, consistent with our CO2 sensor findings. Biochemical structure analyses reveal important phosphorylation sites and provide insight into the direct CO2 sensing and signaling core mechanism in plant cells.

DESCRIPTION

This invention solves a long-term question of how plants sense atmospheric [CO2] changes, and provides a potent tool for improving plant water use efficiency and plant performance under water-limited and also in regions with water-replete conditions, given the continuing steep increase in the atmospheric CO2 concentration.

Plants control water loss and control gas exchange between plant leaves and the atmosphere via stomatal pores. This exchange of gases includes CO2 influx for photosynthesis, O2 efflux, and transpirational water loss through stomatal pores in their leaves. Plants lose over 90% of their water by transpiration. The balance of exchange of water loss and CO2 intake is achieved by a proper control of stomatal apertures in response to environmental stimuli.

Elevation in atmospheric [CO2] induces stomatal closure and impacts plant growth and dramatically water-use efficiency and crop yields. With the present 50% higher CO2 concentration in the atmosphere compared

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OTHER INFORMATION

CATEGORIZED AS

- Agriculture & Animal Science
  - Plant Traits

RELATED CASES

2021-Z08-1

to 100 years ago, and the continuing increase in the CO_2 concentration, plants could take in the same amount of CO_2 from the atmosphere, while losing 33% less water.However, the CO_2/bicarbonate sensor that controls plant transpiration and water use efficiency has remained unknown.

APPLICATIONS

Traits that can be engineered:

Enhance drought tolerance of crop plants.

Enhance growth under the present and continuing elevated CO_2 concentration of crop plants.

Enhance early monitoring of CO_2 elevation effects, drought and heat stress by crop plants and trees.

Early mounting of stress resistance in crop plants and trees.

STATE OF DEVELOPMENT

This patent-pending technology is available for commercialization. Contact UC San Diego's Office of Innovation & Commercialization for availability.

RELATED MATERIALS

- Takahashi Y, Bosmans KC, Hsu PK, Paul K, Seitz C, Yeh CY, Wang YS, Yarmolinsky D, Sierla M, Vahisalu T, McCammon JA, Kangasjärvi J, Zhang L, Kollist H, Trac T, Schroeder JI. Stomatal CO2/bicarbonate sensor consists of two interacting protein kinases, Raf-like HT1 and non-kinase-activity requiring MPK12/MPK4. Sci Adv. 2022 Dec 9;8(49) - 12/07/2022
- Dubeaux G, Hsu PK, Ceciliato PHO, Swink KJ, Rappel WJ, Schroeder JI. Deep dive into CO2-dependent molecular mechanisms driving stomatal responses in plants. Plant Physiol. 2021 Dec 4;187(4):2032-2042 - 12/04/2021
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