Sensing sugar and saving water

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Abstract

Water is the major factor limiting the growth and development of many land plants, and stomata, composed of two guard cells, are the chief gates controlling plants’ water loss. Many environmental and physiological stimuli control stomatal opening, but they all do so through the regulation of guard-cell osmolarity. Increased guard-cell osmolarity leads to the opening of the stomata and decreased osmolarity causes the stomata to close. The prevailing paradigm is that sugars act as osmoticum in the guard cells, thereby contributing to the opening of the stomata. In contrast, we discovered that sugars close stomata via a non-osmotic mechanism. Furthermore, our results show that the guard cells’ response to sugars is dependent on the sugar-sensing enzyme hexokinase (HXK), which triggers the abscisic acid-signaling pathway within the guard cells, leading to stomatal closure. These findings reveal a feedback-inhibition mechanism that is mediated by a product of photosynthesis, sugar via HXK. HXK in the guard cells senses the sugar level and stimulates stomatal closure, thereby coordinating the sugar level with the rate of transpiration. Increased expression of HXK in guard cells decreases the transpiration rate and improves whole-plant water-use efficiency, with no negative effects on photosynthesis, growth or yield.

Keywords: Guard cells; Hexokinase (HXK); Stomata; Sugar sensing; Transpiration; Water Use Efficiency (WUE)

References

