Diurnal Fluctuations in Water Absorption Efficiency of Rice (Oryza sativa) Based on Aquaporin Expression and Stomatal Opening and Closing Rhythms

Maeda, Ayaka (School: Notre Dame Seishin Gakuen Seishin Girls' High School)

Management of crop irrigation is a very important in modern agriculture. Here, we aimed to elucidate the diurnal water uptake mechanisms employed by rice, one of the most cultivated grains in the world. First, water uptake and root hydraulic conductivity were quantified in rice (Oryza sativa) plants maintained under a photoperiod of LD 12:12 at 25°C. Next, diurnal variations in aquaporin mRNA and protein synthesis in the roots were estimated by RT-PCR and western blotting. To clarify the relationship between water uptake and transpiration, diurnal fluctuations in stomatal openings were investigated. Water uptake in rice increased approximately 3 h before the onset of the light period and decreased approximately 2 h before the onset of the dark period. Further, root hydraulic conductivity increased as the dark period transitioned to the light period. Four aquaporin genes were transcriptionally activated before the onset of the light period, and two of these genes showed elevated translation levels until just after the onset of the dark period. Interestingly, stomatal opening only occurred during the light period. In roots, aquaporin gene expression before the onset of the dark period is associated with increased water uptake and increased water uptake efficiencies. At the onset of the light period, water uptake and transportation are promoted by transpiration through stomatal openings. Peak water absorption efficiency is considered to occur immediately before dawn. The findings of this study could contribute to the understanding of water movement in plants.

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