Functions of Arabidopsis sulfate transporter SULTR2;1 in sulfur metabolism and plant growth

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(硫黄代謝と植物成長におけるシロイヌナズナ硫酸イオン輸送体 SULTR2;1 の機能)

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Thesis Summary

Sulfur (S) is an essential macronutrient for plant growth and metabolism. Plants take up S from the soil environment as sulfate through the activities of several sulfate transporters (SULTRs). Sulfate absorbed by the cells is converted to 5'-adenylyl sulfate (APS) and reduced to sulfite by APS reductase. Then, sulfite is reduced to sulfide by sulfite reductase, and the resulting sulfide reacts with *O*-acetyl-L-serine to form cysteine. Cysteine is the primary product of sulfate assimilation and is used to synthesize various organic S-containing compounds, such as glutathione (GSH), methionine, and glucosinolates.

In *Arabidopsis thaliana,* twelve SULTRs are classified into four groups according to their protein sequences, and their biochemical characteristics, tissue-specific expression, and physiological functions have been studied. Among them, SULTR2;1 is a low-affinity sulfate transporter facilitating the long-distance transport of sulfate in *Arabidopsis*. Besides intensive studies about the functions of SULTRs in the seedling stage, few reports evaluated the effects of their disruption on plant growth and development, including SULTR2;1. Therefore, we analyzed the sulfate transport, S-containing metabolites accumulation, and plant growth using *Arabidopsis SULTR2;1* disruption lines, *sultr2;1-1* and *sultr2;1-2,* from seedling to mature growth stages to clarify the metabolic and physiological roles of SULTR2;1.

We observed that sulfate distribution to the stems was affected in a *sultr2;1* mutant, resulting in decreased levels of sulfate, cysteine, glutathione (GSH), and total S in the stems, flowers, and siliques; however, the GSH levels increased in the rosette leaves. This suggested the essential role of SULTR2;1 in sulfate transport from rosette leaves to the primary stem. In addition, *sultr2;1* mutants unexpectedly bolted earlier than the wild-type without affecting the plant biomass. Correlation between GSH levels in rosette leaves and the bolting timing suggested the rosette leaf GSH levels or limited sulfate transport to the early stem can trigger bolting. Overall, we demonstrated the critical roles of SULTR2;1 in maintaining the S metabolite levels in the aerial part and transitioning from the vegetative to the reproductive growth phase.