Cold-induced intermediary cell-specific overexpression of galactinol synthase 1 revealed an unique strategy improving stress adaptability of Cucumber

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Abstract

Cucumber (*Cucumis sativus* L.) predominately translocates raffinose family oligosaccharides (RFOs) in the phloem and also accumulates RFOs in leaves under stress. Galactinol synthase (GolS) catalyzes the critical step of RFOs biosynthesis and it is interesting to know the expression pattern and function diversity of multiple GolS isoforms in cucumber. In this study, we found all four *CsGolS* transcripts were up-regulated by different abiotic stresses. β-glucuronidase staining and tissue separation experiments suggested that *CsGolS1* expresses in vascular tissues while other three *CsGolSs* are located in mesophyll cells. Phylogenetic analysis revealed that except *Cucurbita*, *GolS* promoters of all other cucurbits in group I own intermediary cell (IC)-specific *cis*-sequences, indicating this group is responsible for RFOs loading. Further investigation indicated that *CsGolS1* plays double roles in both assimilate loading and stress adaptation in the IC, which could increase the RFOs concentration in the phloem sap and then improve the assimilate transport under adverse conditions. Cold-induced IC-specific overexpression of *CsGolS1* enhanced the assimilate translocation efficiency and accelerated growth rates of sink leaves, fruits and whole plants under cold stress. Finally, our results demonstrate an unique mechanism of cucumber to adapt adverse environment and provide a potential biotechnological strategy to improve stress resistance of cucurbits.

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