Carbon availability controls shoot growth through sugar-induced cytokinin biosynthesis and transport in *Arabidopsis*

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Carbon nutrient availability is a major regulatory factor of plant growth and development. Although a plant hormone cytokinin, which plays an important role in various aspects of plant growth and development, has been implicated in the carbon availability-dependent regulation, the details of their involvement remain to be elucidated. Here we report that shoot growth enhancement under elevated CO_2 is mediated by sugar-induced cytokinin biosynthesis and transport in *Arabidopsis thaliana*. Treatment of Arabidopsis seedlings in elevated CO_2 resulted in an accumulation of cytokinin precursors in shoots and roots that preceded shoot growth enhancement, indicating that cytokinin *de novo* biosynthesis is activated. Among genes involved in the *de novo* biosynthesis, only two genes, an adenosine phosphate-isopentenyltransferase gene, *AtIPT3*, and a cytochrome P450 monooxygenase gene, *CYP735A2,* were consistently induced in response to elevated CO_2 in the root. In addition, *ABCG14*, a gene involved in root-to-shoot transport of cytokinin, were induced similarly to *AtIPT3* and *CYP735A2*. The expression of these genes was inhibited by dark treatment and a photosynthesis inhibitor, DCMU, under elevated CO_2 and was enhanced by sugar supplement, indicating that photosynthetically generated sugars are responsible for the induction. The *ipt3 ipt5 ipt7* and *cyp735a1 cyp735a2* mutants, defective in elevated CO_2-induced cytokinin accumulation, were impaired in shoot growth enhancement under elevated CO_2, demonstrating the requirement of cytokinin *de novo* biosynthesis in the growth response. We propose that plants employ an intricate system to regulate shoot growth in response to elevated CO_2, in which photosynthetically generated sugars induce cytokinin *de novo* biosynthesis and transport in the root for shoot growth regulation.