The Effects of Copper Deficiency on Phytohormonal Biosynthesis and Signaling Pathways

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Advancements in plant science have striven to breed more resilient crops to address the pressing contemporary issues of food insecurity, which require a concrete understanding of the nutritional demands of plants. Copper (Cu) is a critical micronutrient in plants, acting as an indispensable cofactor in key redox reactions and a necessary component in ensuring fertility. Additionally, preliminary findings have defined a connection between Cu and vital growth-regulating phytohormones, namely ethylene and jasmonic acid. However, a relationship between Cu and other key phytohormones has not yet been explored. This research analyzed the effects of Cu deficiency on the biosynthesis and signaling pathways of the phytohormones auxin, gibberellins (GA), cytokinins (CK), and abscisic acid (ABA), using RNA-seq datasets collected in 2017 of differentially expressed genes (DEGs) in Arabidopsis thaliana grown in Cu-deficient conditions. It was hypothesized that various target genes in the pathways of auxin, GA, CK, and ABA would be differentially expressed under Cu deficiency. By learning extensively about these phytohormones through previous literature, target genes in these pathways were identified, and the datasets were used to determine if these genes were differentially expressed under Cu deficiency and to analyze pathway responses. Many genes in each phytohormonal pathway were differentially expressed, supporting the hypothesis. However, the overall response of each of these pathways to Cu deficiency varied: Cu deficiency triggered an overall positive response in the pathways of auxin, GA, and ABA biosynthesis but repressed the pathways of CK and led to a more ambiguous response in the ABA signaling pathway.

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