Research highlights

Title of story: A lipid synthase maintains metabolic flux for jasmonate synthesis to regulate root growth and phosphate homeostasis

Brief Story:

Plants require phosphate (Pi) for proper growth and development but often face scarcity of this vital nutrient in the soil. Pi starvation triggers membrane lipid remodeling to utilize the membrane phospholipid-bound Pi in plants. In this process, phospholipids are replaced by non-Pi-containing galactolipids (monogalactosyldiacylglycerol, MGDG; digalactosyldiacylglycerol, DGDG) and sulfolipids. The galactolipids ratio (MGDG:DGDG) is suggested to influence jasmonic acid (JA) biosynthesis. However, how the MGDG:DGDG ratio, JA levels, and root growth are coordinated under Pi deficiency in rice (Oryza sativa) remains unknown. Here, we characterized DGDG synthase 1 (OsDGD1) for its role in regulating root development by maintaining metabolic flux for JA biosynthesis. We showed that OsDGD1 is responsive under low Pi and is under the direct control of Phosphate Starvation Response 2, the master regulator of low Pi adaptations. Further, OsDGD1 knockout (KO) lines showed marked phenotypic differences compared to the wild type, including a significant reduction in root length and biomass, leading to reduced Pi uptake. Further, lipidome analyses revealed reduced DGDG levels in the KO line, leading to reduced membrane remodeling, thus affecting P utilization efficiency. We also observed an increase in the MGDG:DGDG ratio in KO lines, which enhanced the endogenous JA levels and signaling. This imbalance of JA in KO plants led to changes in auxin levels, causing drastic root growth inhibition. These findings indicate the critical role of OsDGD1 in maintaining optimum levels of JA during Pi deficiency for conducive root growth. Besides acting as signaling molecules and structural components, our study widens the role of lipids as metabolic flux controllers for phytohormone biosynthesis.

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