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Melatonin mitigates drought stress by increasing sucrose synthesis and suppressing abscisic acid biosynthesis in tomato seedlings

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Abstract

The increasing prevalence of drought events poses a major challenge for upcoming crop production. Melatonin is a tiny indolic tonic substance with fascinating regulatory functions in plants. While plants can respond in several ways to alleviate drought stress, the processes underpinning stress sensing and signaling are poorly understood. Hereafter, the objectives of this investigation were to explore the putative functions of melatonin in the regulation of sugar metabolism and abscisic acid biosynthesis in drought-stressed tomato seedlings. Melatonin (100 μM) and/or water were foliar sprayed, followed by the plants being imposed to drought stress for 14 days. Drought stress significantly decreased biomass accumulation, inhibited photosynthetic activity, and stimulated senescence-associated gene 12 (SAG12) expression. Melatonin treatment effectively reversed drought-induced growth retardation as evidenced by increased leaf pigment and water balance and restricted abscisic acid (ABA) accumulation. Sugar accumulation, particularly sucrose content, was higher in drought-imposed seedlings, possibly owing to higher transcription levels of sucrose non-fermenting 1-related protein kinase 2 (SnKR2.2) and ABA-responsive element binding factors 2 (AREB2). Melatonin addition further uplifted the sucrose content, which coincided with increased activity of sucrose synthase (SS, 130%), sucrose phosphate synthase (SPS, 137%), starch degradation encoding enzyme β-amylase (BAM, 40%) and α-amylase (AMY, 59%) activity and upregulated their encoding BAM1(10.3 folds) and AMY3 (8.1 folds) genes expression at day 14 relative to the control. Under water deficit conditions, melatonin supplementation decreased the ABA content (24%) and its biosynthesis gene expressions. Additionally, sugar transporter subfamily genes SUT1 and SUT4 expression were upregulated by the addition of melatonin. Collectively, our findings illustrate that melatonin enhances drought tolerance in tomato seedlings by stimulating sugar metabolism and negatively regulating ABA synthesis.

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