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Synergistic Effects of Hydrogen Sulfide and Melatonin in Alleviating Vanadium Toxicity in Solanum lycopersicum L. Plants

Authors : Abazar Ghorbani, W. M. Wishwajith W. Kandegama, Seyed Mehdi Razavi, Moxian Chen

Abstract : The roles of hydrogen sulfide (H_2S) and melatonin (MT) as gasotransmitters in plants are widely recognised. Nevertheless, the precise nature of their involvement in defensive reactions remains uncertain. This study investigates the impact of the ML-H2S interaction on tomato plants exposed to vanadium (V) toxicity, focusing on synthesising secondary metabolites and V metal sequestration. The treatments applied in this study included a control (T1), V stress (T2), MT+V (T3), MT+H2S+V (T4), MT+hypotaurine (HT)+V (T5), and MT+H2S+HT+V (T6). These treatments were administered: MT (150 µM) as a foliar spray pre-treatment (3X), HT treatment (0.1 mM, an H2S scavenger) as root immersion for 12 hours as pre-treatments, and H2S (NaHS, 0.2 mM) and V (40 mg/L) treatments added to the Hoagland solution for 2 weeks. Results demonstrate that ML and H2S+ML treatments alleviate V toxicity by promoting the transcription of key genes (ANS, F3H, CHS, DFR, PAL, and CHI) involved in phenolic and anthocyanin biosynthesis. Moreover, they decreased V uptake and accumulation and enhanced the transcription of genes involved in glutathione and phytochelatin synthesis (GSH1, PCS, and ABC1), leading to V sequestration in roots and protection against V-induced damage. Additionally, ML and H2S+ML treatments optimize chlorophyll metabolism, and increase internal H2S levels, thereby promoting tomato growth under V stress. The combined treatment of ML+H2S shows superior effects compared to ML alone, suggesting synergistic/interactive effects between these two substances. Furthermore, inhibition of the beneficial impact of ML+H2S and ML treatments by HT, an H2S scavenger, underscores the significant involvement of H_2S in the signaling pathway activated by ML during V toxicity. Overall, these findings suggest that ML requires the presence of endogenous H_2S to mitigate V-induced adverse effects on tomato seedlings.

Keywords : vanadium toxicity, secondary metabolites, vanadium sequestration, h2s-melatonin crosstalk
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