Investigating the Role of Rhizosphere Chemistry in Wheat Drought Stress: A Metabolomics Study

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ABSTRACT

Introduction: Drought stress poses a significant challenge to crop productivity, necessitating innovative strategies for mitigation. The root microbiome has emerged as a potential solution, with certain root-associated bacteria demonstrating the ability to alleviate the adverse effects of drought on plant growth (Sokol, Noah W., et al. 2022, Zgadzaj, Rafal, et al. 2016). However, the impact of drought on the development of the root microbiome remains inadequately explored (Naylor, Dan, et 2017). This study focuses on wheat, a pivotal cereal strongly affected by drought, to unravel the morphological, root exudation, and metabolic responses of two wheat varieties: Pakistan-13 (susceptible) and Dharabhi-11 (tolerant) under varying drought conditions.

Objectives: The primary objectives of this study are to investigate the morphological changes, root exudation patterns, and metabolic responses in two wheat varieties subjected to different durations of drought stress. By withholding irrigation for five days (5 DAI), ten days (10 DAI), and fifteen days (15 DAI), alongside control conditions, we aim to discern the nuanced variations in root architecture and metabolite production under varying drought intensities.

Methodology: Morphological analyses encompassing fresh and dry biomass, surface area, and root characteristics (length and diameter) were conducted on Pakistan-13 and Dharabhi-11 wheat varieties. Additionally, stress-related volatile metabolites from the rhizosphere were quantified using Gas Chromatography-Mass Spectrometry (GC-MS) (Musharraf, Syed Ghulam, et al 2013). The study provides a detailed insight into the metabolite profiles of the two varieties, elucidating diverse groups such as amino acids, alkaloids, organic acids, flavonoids, and sugars. Notably, metabolite analyses were performed under extreme drought conditions (15 DAI) to discern potential roles in drought stress tolerance.

Conclusion/Results: Results unveiled a diverse spectrum of metabolites, with Pakistan-13 exhibiting sixty-nine and Dharabhi-11 ninety-six metabolites. The latter showcased 43 significantly active metabolites under extreme drought conditions, suggesting a pivotal role in drought stress tolerance. Dharabhi-11 also displayed a robust root architecture accompanied by a diverse metabolite spectrum, indicative of its ability to reshape the microecology of roots with high drought tolerance. These findings contribute valuable insights for drought stress management in wheat microhabitats, offering potential solutions to address food security challenges in the face of changing climates.

Keywords: Acetyl cholinesterase, Alzheimer's disease, Butrylcholinesterase, Nutraceutical, *Sargassum Illicifolium*

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