Sustainable Reuse of Cadmium-Contaminated Textile Wastewater in Wheat Cultivation: A Nano-Physiological and Transcriptomic Perspective

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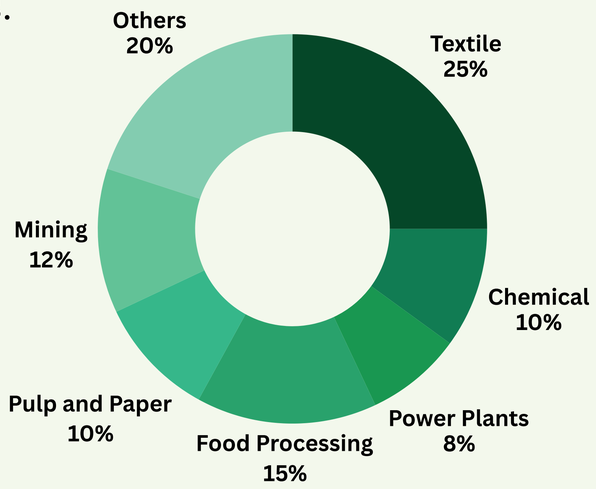
INTRODUCTION

- Cadmium (Cd) contamination from textile dyeing wastewater is a major constraint on sustainable wheat production.
- Cd interferes with photosynthetic efficiency, redox homeostasis, nutrient uptake, and cellular integrity, ultimately reducing biomass and yield while posing serious food-safety risks.
- Intensified Cd entry into agro-ecosystems, demanding effective remediation strategies that are both agronomically viable and environmentally sustainable.



PROBLEM

- Cadmium in textile wastewater persists post-treatment, contaminating crops and threatening food safety despite investments.
- Lack of integrated strategy linking effluent detoxification, crop stress relief, and molecular understanding for safe agriculture.

OBJECTIVES

- Compare Bio-FeO-NPs & Chem-FeO-NPs for superior Cd stress mitigation in wheat.
- Elucidate FeO-NP defense pathways through physiological and biochemical analyses, and understand transcriptomic mechanisms of Wheat under Cd stress.

CONCLUSION

- Biogenic iron nanoparticles efficiently detoxified cadmium-rich textile wastewater and significantly improved wheat growth and physiology.
- Transcriptomic network analysis revealed ten core hub genes whose significant dysregulation under cadmium stress positions them as key regulators of cellular stress and detoxification mechanisms.

DISCUSSION

- Biologically synthesized iron nanoparticles significantly mitigate cadmium toxicity by improving wastewater quality and restoring plant physiological and biochemical homeostasis. This dual remediation–growth-promotion effect highlights their potential as a sustainable nanobiotechnological strategy for industrial wastewater reuse in agriculture.

REFERENCES

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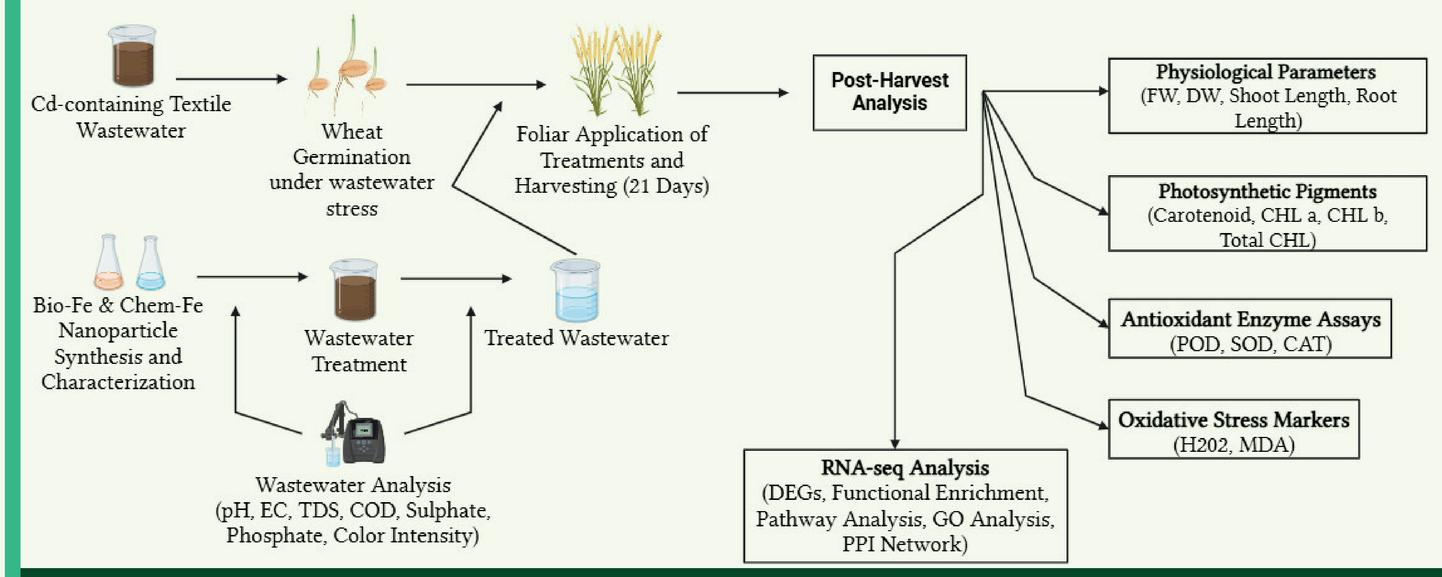
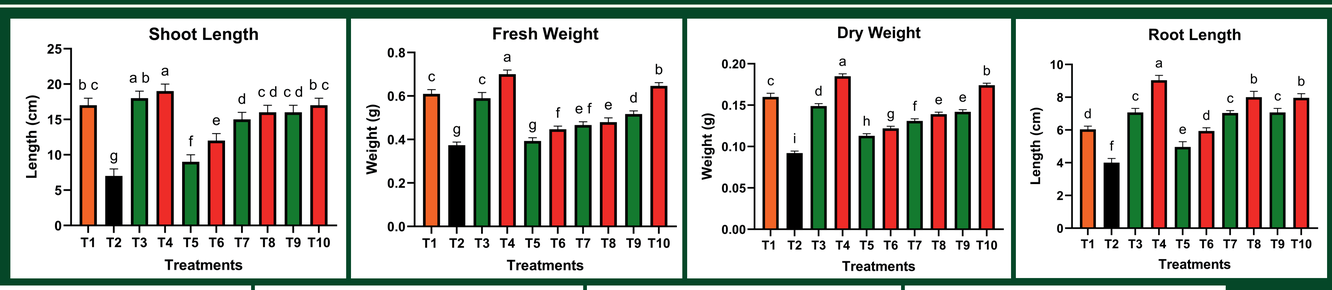
- Syed Mazhar Irfan, & Khizar Hayat Bhatti. (2023). Zinc Oxide Nanoparticles Mitigate Toxic Effects of Cadmium Heavy Metal in Chilli (Capsicum annuum L.). Proceedings of the Pakistan Academy of Sciences: B. Life and Environmental Sciences, 60(3), 477–487. https://doi.org/10.53560/PPASB(60-3)854

METHODOLOGY

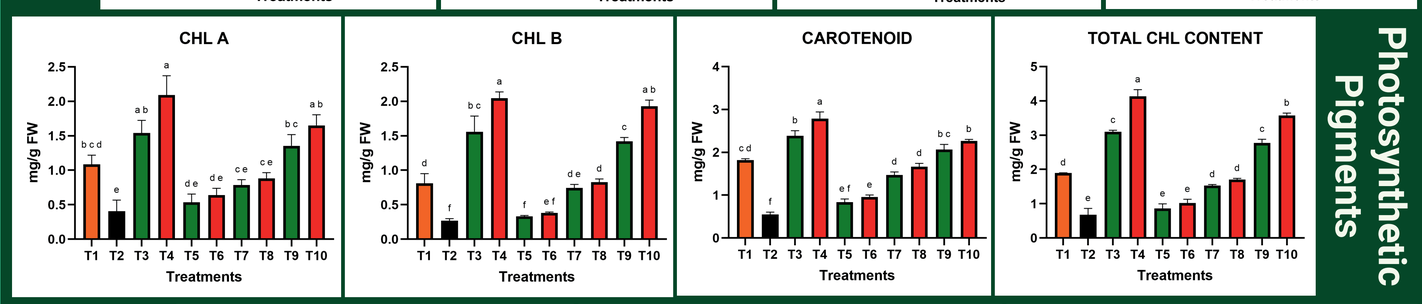


RESULTS

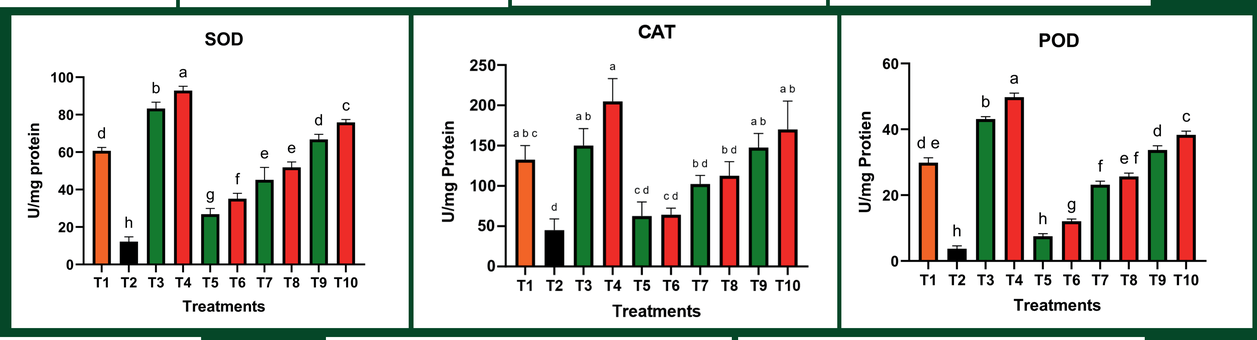
Physiological Parameters



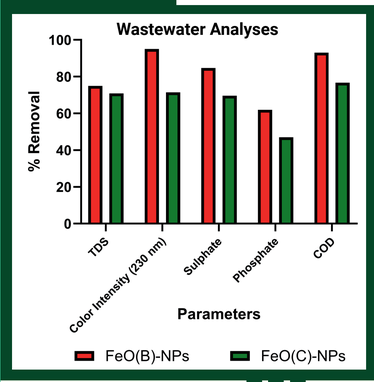
Photosynthetic Pigments



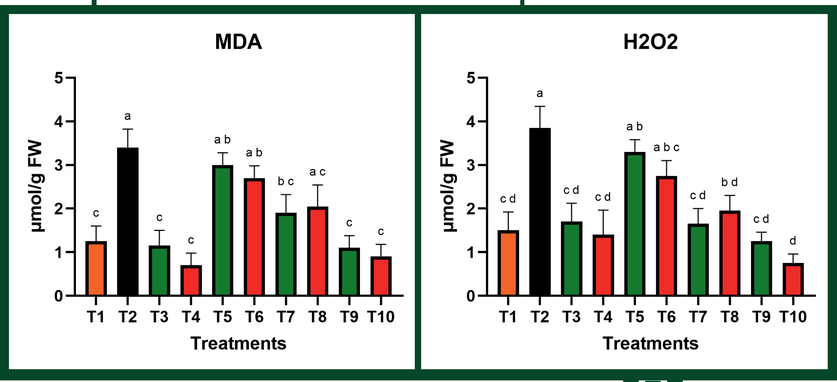
Antioxidant Enzymes Assays



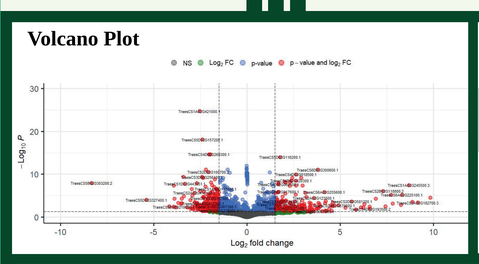
Wastewater Analyses

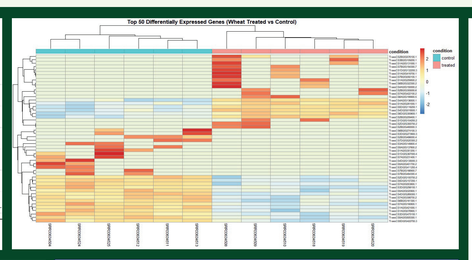


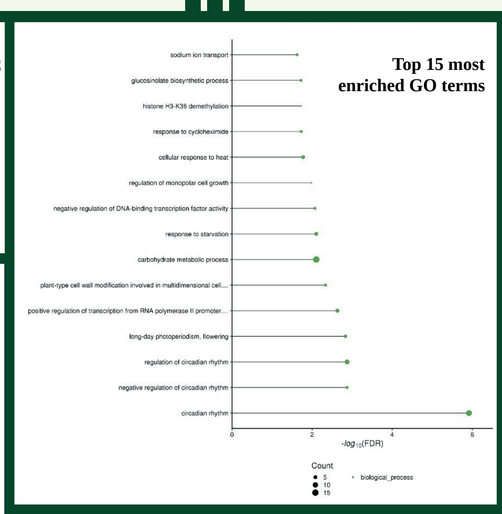
Oxidative Stress Markers

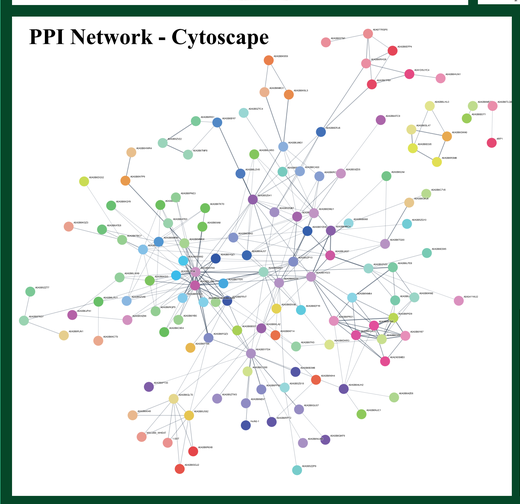


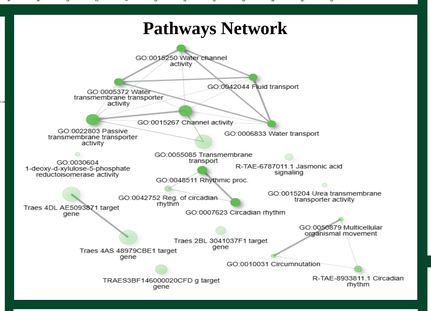
TRANSCRIPTOMICS

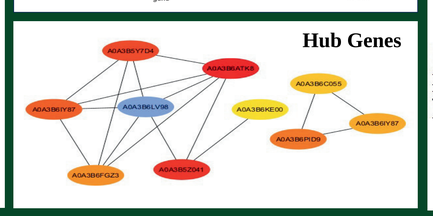


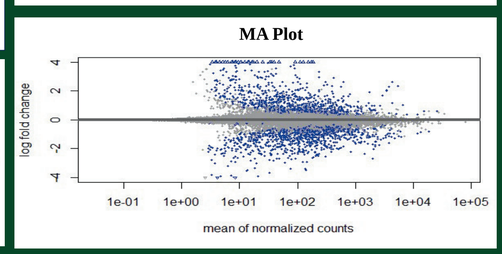












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