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Student Name: Himanshu Saini

Supervisor's Name: Prof. Meetu Gupta

Name of the Department: Department of Biotechnology

Findings

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Arsenic (As) toxicity poses a significant threat to agriculture, particularly in regions of Gangetic Plains of India, where contaminated groundwater contributes to soil accumulation of As over time. This study investigates the impact of As contamination on rice and wheat growing in the Ballia district, Uttar Pradesh, under natural conditions. The research integrates analytical techniques such as ICP-MS for As and nutrient content estimation, metabolomics via LC-MS/MS and UHPLC, physiological assessments, and gene expression analysis.

The findings reveal As levels in soil and water at all study sites -exceeding WHO safety standards. Variations in soil physicochemical attributes, including pH, organic carbon, and texture, significantly influence As dynamics. Certain rice and wheat genotypes demonstrated enhanced As tolerance, associated with the accumulation of specific key metabolites such as amino acids (Ala, Glu), phenolic compounds (p-coumaric acid, chlorogenic acid), and flavonoids (rutin, kaempferol, naringenin). Metabolic pathways like amino acid metabolism and phenylpropanoid biosynthesis emerged as crucial for As resilience. Ionomic analysis highlighted changes in essential minerals that influence plant adaptation.

Among the genotypes studied, Mini mansoori (rice) and Malviya-234 (wheat) stood out for their As-free, nutrient-metabolite-rich grains and good yield. This research provides valuable insights for breeding As-resistant crop varieties.