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Unravelling Glyphosates Disruptive Effects on the Photochemical Efficiency of Amaranthus cruentus

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Abstract : Context: Glyphosate, a widely used herbicide, has raised concerns about its impact on various crops. Amaranthus cruentus, an important grain crop species, is particularly susceptible to glyphosate. Understanding the specific disruptions caused by glyphosate on the photosynthetic process in Amaranthus cruentus is crucial for assessing its effects on crop productivity and ecological sustainability. Research Aim: This study aimed to investigate the dose-dependent impact of glyphosate on the photochemical efficiency of Amaranthus cruentus using the OJIP transient analysis. The goal was to assess the specific disruptions caused by glyphosate on key parameters of photosystem II. Methodology: The experiment was conducted in a controlled greenhouse environment. Amaranthus cruentus plants were exposed to different concentrations of glyphosate, including half, recommended, and double the recommended application rates. The photochemical efficiency of the plants was evaluated using non-invasive chlorophyll a fluorescence measurements and subsequent analysis of OJIP transients. Measurements were taken on 1-hour dark-adapted leaves using a Hansatech Handy PEA+ chlorophyll fluorimeter. Findings: The study's results demonstrated a significant reduction in the photochemical efficiency of Amaranthus cruentus following glyphosate treatment. The OJIP transients showed distinct alterations in the glyphosate-treated plants compared to the control group. These changes included a decrease in maximal fluorescence (FP) and a delay in the rise of the fluorescence signal, indicating impairment in the energy conversion process within the photosystem II. Glyphosate exposure also led to a substantial decrease in the maximum quantum yield efficiency of photosystem II (FV/FM) and the total performance index (PItotal), which reflects the overall photochemical efficiency of photosystem II. These reductions in photochemical efficiency were observed even at half the recommended dose of glyphosate. Theoretical Importance: The study provides valuable insights into the specific disruptions caused by glyphosate on the photochemical efficiency of Amaranthus cruentus. Data Collection and Analysis Procedures: Data collection involved non-invasive chlorophyll a fluorescence measurements using a chlorophyll fluorimeter on dark-adapted leaves. The OJIP transients were then analyzed to assess specific disruptions in key parameters of photosystem II. Statistical analysis was conducted to determine the significance of the differences observed between glyphosate-treated plants and the control group. Question Addressed: The study aimed to address the question of how glyphosate exposure affects the photochemical efficiency of Amaranthus cruentus, specifically examining disruptions in the photosynthetic electron transport chain and overall photochemical efficiency. Conclusion: The study demonstrates that glyphosate severely impairs the photochemical efficiency of Amaranthus cruentus, as indicated by the alterations in OJIP transients. Even at half the recommended dose, glyphosate caused significant reductions in photochemical efficiency. These findings highlight the detrimental effects of glyphosate on crop productivity and emphasize the need for further research to evaluate its long-term consequences and ecological implications in agriculture. The authors gratefully acknowledge the support from North-West University for making this research possible.

Keywords : glyphosate, amaranthus cruentus, ojip transient analysis, pitotal, photochemical efficiency, chlorophyll fluorescence, weeds

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