

Evaluating the Ecotoxicological Effects of Glyphosate on Soil Systems: Towards Sustainable Agroecosystems

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INTRODUCTION & AIM

Glyphosate ($C_3H_8NO_5P$) is a broad-spectrum herbicide commonly used in agriculture to effectively control weeds in cereal, vineyard, and horticultural crops. However, excessive application of glyphosate can negatively impact soil health by altering microbial diversity, disrupting nutrient cycling, and reducing fertility and biodiversity [1]. Furthermore, prolonged exposure to glyphosate has been linked to potential health risks for humans, including cancer and endocrine disruption. The International Agency for Research on Cancer (IARC, 2015) classified glyphosate as "probably carcinogenic to humans" (Group 2A), which emphasizes the importance of stricter regulations and environmentally responsible agricultural practices [2]. This study aimed to evaluate the phytotoxicity of glyphosate on the germination of *Raphanus sativus* (Turnip) and *Lepidium sativum* (watercress) seeds. This study contributes to our understanding of the environmental risks associated with increasing concentrations of this compound in agroecosystems.

METHOD



Figure 1. Commercial Glyphosate formulation Montanag®, manufactured by Ascenza Agro, S.A. and concentrations tested.

A triplicate bioassay was conducted using glyphosate concentrations of 3.6, 1.8, 0.9, 0.45, and 0.225 g/L. Twenty seeds of each species (turnip and watercress) were uniformly placed in Petri dishes containing cotton soaked with 15 mL of each test solution. After seven days, the number of germinated seeds was recorded, and the median lethal concentration (LC_{50}) values were calculated. Statistical analyses were performed to assess the relationship between glyphosate concentration and germination inhibition.

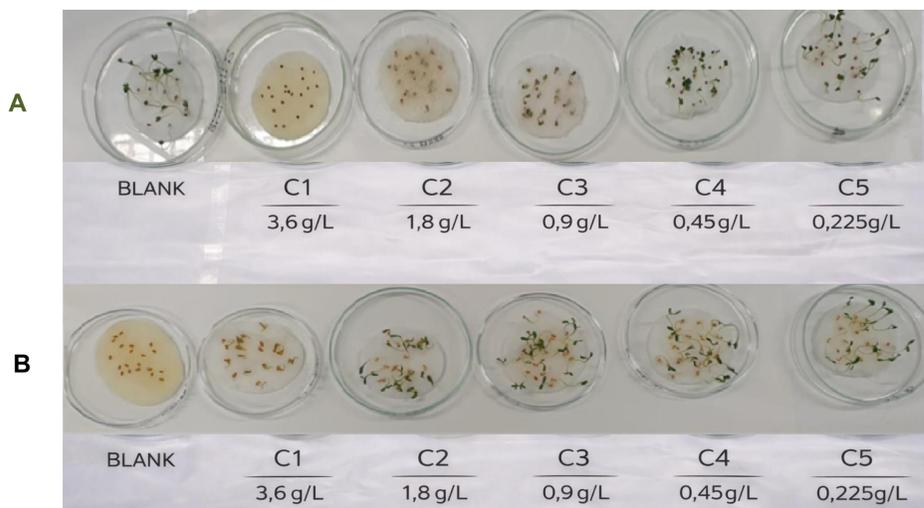


Figure 2 – Seed germination assay after 7 days in the presence of the herbicide glyphosate. **A** – Turnip seeds; **B** – Watercress seeds

RESULTS & DISCUSSION

The control group showed 18 germinated seeds, validating the assay and allowing a graph to be constructed for each tested species. Dilutions were prepared from a labeled base concentration of 20 g/L, with tested concentrations ranging from 3.6 g/L to 0.225 g/L.

Table 1. Effect of Glyphosate Concentration on Seed Germination

Prepared dilutions (C ₃ H ₈ NO ₅ P)	Glyphosate (g/L)	Turnip Germinated Seeds	Watercress Germinated Seeds
C ₁	3,6	0	5
C ₂	1,8	3	9
C ₃	0,9	10	17
C ₄	0,45	18	17
C ₅	0,225	20	15

Dose–response curves (Figures 3 and 4) showed a strong relationship between glyphosate concentration and germination inhibition. A marked change in inhibition occurred between 1.8 g/L and 3.6 g/L for both species.

Turnip seeds showed higher inhibition rates than watercress, indicating greater sensitivity to glyphosate.

A significant positive correlation was observed between glyphosate concentration and germination inhibition for both species

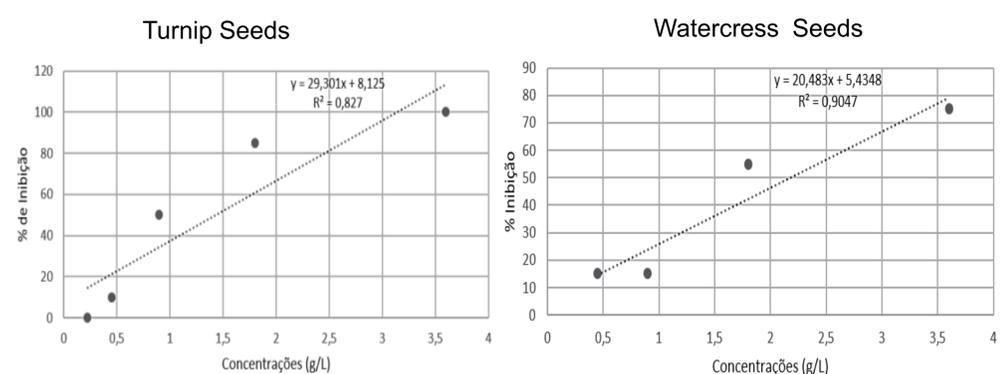


Figure 3 – Percentage of Inhibition in Turnip Seeds in the Presence of Glyphosate

Figure 4 – Percentage of Inhibition in Watercress Seeds in the Presence of Glyphosate

CONCLUSION

The results of this study clearly demonstrate that glyphosate exhibits significant phytotoxicity, as evidenced by the strong positive correlation between glyphosate concentration and inhibition rate. The LC_{50} values obtained were 2.18 g/L for Watercress seeds and 1.43 g/L for Turnip seeds. These results confirm that glyphosate exerts toxic effects on seed germination.

The study emphasizes the need for continuous environmental monitoring and the adoption of sustainable soil management practices to mitigate glyphosate's ecological impact.

REFERENCES

[1] Klátyik, S., Simon, G., Takács, E., Oláh, M., Zaller, J. G., Antoniou, M. N., ... & Székács, A. (2025). Toxicological concerns regarding glyphosate, its formulations, and co-formulants as environmental pollutants: a review of published studies from 2010 to 2025. *Archives of Toxicology*, 99(8), 3169-3203.

[2] IARC (International Agency for Research on Cancer). (2015). "Evaluation of five organophosphate insecticides and herbicides." *IARC Monographs on the Evaluation of Carcinogenic Risks to Humans*, 112, 1-106