OPEN ACCESS

Scientific Letters

III 1H-TOXRUN
International Congress 2024
02-03 May, 2024 | Porto, Portugal

*Poster 71*

# Development of image classification models for the identification of earthworms exposed to glyphosate-based herbicide: a pilot study

**Diovana Gelati de Batista [1,*], Juliana Furlanetto Pinheiro [1], Isadora Sulzbacher Ourique [1], Vítor Basto Fernandes [2], Rafael Z. Frantz [1], Nuno Costa [3] and Thiago Gomes Heck [1]**

[1] Regional University of Northwestern Rio Grande do Sul, Rua do Comércio 3000, Ijuí, RS, Brazil, CEP 98700-000
[2] Instituto Universitário de Lisboa (ISCTE-IUL), Centro de Investigação em Ciências da Informação, Tecnologias e Arquitetura, Lisboa, Portugal
[3] Computer Science and Communication Research Center, School of Technology and Management, Polytechnic University of Leiria, Campus 2, Morro do Lena, Alto do Vieiro, 2411-901, Leiria, Portugal

* Correspondence: diovana.g.batista@gmail.com

## Abstract

**Background:** Glyphosate-based herbicides (GBH) may threaten ecosystems and human health [1]. Animal models using earthworms as environmental bioindicators have been proposed [2], but they must be practical and cheaper [3]. **Objective:** We test if machine learning models of earthworm image classification can be used to identify GBH-exposed environments. **Methods:** 144 adults *Eisenia andrei* earthworms were divided into Control (water), GBH1.5, GBH3.0, and GBH6.0 groups (Roundup® Original DI, equivalent to 1.5, 3.0, and 6.0 L/ha). After 48 hours, each worm was photographed at least two times with a mobile camera (76-88 images/group). Random images were used to train models (85%) and separated for testing (15%). Also, we generated 20 artificial images (AI) variations of each original image (OI) using data augmentation techniques using imgaug library [4], reaching >1,600 images/group. Thus, we trained models six times each in Google's Teachable Machine with 50, 20, and 10 epochs (learning rate=0.001; batch size=16) using OI with the four (OI-4G) or two groups (OI-2G, Control vs. GBH6.0), or using AI (AI-4G or AI-2G). The resulting models were tested using Python with new images, and the accuracy was compared using 2-way ANOVA, followed by Tukey's test. **Results:** The OI-2G model showed better accuracy when trained with 50 epochs (P=0.02), but the AI-2G model presented the best accuracy in all epochs tested (P < 0.002). In contrast, the OI-4G model presented the worst performance compared to the others (P<0.0001) (% Accuracy: OI-4G=52±5; OI-2G=77±5; AI-4G=79±3; AI-2G=93±3). When tested, AI models had lower accuracy when compared to OI models (%Accuracy: OI-4G=47; OI-2G=86; AI-4G=38; AI-2G=65). **Conclusions:** It is possible to detect the presence of GBH in the soil by evaluating earthworm images using machine learning models, even with small sample sizes (photos) and without images created artificially. Models need to be improved to detect the concentration of GBH.

**Keywords:** glyphosate; soil pollution; image model; machine learning

## Acknowledgments

This study was partially supported by the Coordination for the Improvement of Higher Education Personnel (CAPES) in Brazil, under grant 001, and by the Brazilian National Council for Scientific and Technological Development (CNPq) under grants 307926/2022-2 and 405546/2023-8 to TGH, and 309425/2023-9 to RZF.

## References

1. Van Bruggen, A.H.C. et al. Environmental and health effects of the herbicide glyphosate. Sci Total Environ (2018) 616-617, p. 255-268.
2. Zaller, J.G. et al. Effects of glyphosate-based herbicides and their active ingredients on earthworms, water infiltration and glyphosate leaching are influenced by soil properties. Environ Sci Eur (2021) 33, p. 51.

3. Valle, A.L. et al. Glyphosate detection: methods, needs and challenges. Environ Chem Lett (2019), 17, p. 291-317.
4. Imgaug library documentation: https://imgaug.readthedocs.io/en/latest/