

EXPLORING THE FUTURE POTENTIAL OF BIOPESTICIDES IN EUROPE

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Pesticides are usually defined as chemically active substances used to prevent, control, or destroy pests during crop production, storage, or transport stages. These chemicals can include herbicides, fungicides, insecticides, acaricides, nematocides, molluscicides, growth regulators, repellents, and rodenticides (Duarte et al. 2021¹).

However, synthetic pesticides have been found to have hazardous effects on both human health and the environment. These adverse health effects include respiratory, dermatological, gastrointestinal, neurological, endocrine, and reproductive effects, as well as water, air, and soil contamination, pest resistance, or biodiversity reduction. Furthermore, the World Health Organization (WHO) validates this evidence by considering pesticides as “intrinsically toxic and deliberately spread in the environment.”

The continuous flow of news and highlights about agriculture's environmental impact has created societal concerns, pushing for more sustainable farming and food production. As a result, it has become crucial to closely monitor and strictly regulate the use of pesticides in agriculture while searching for new alternatives. The goal of a world that doesn't depend on pesticides but can guarantee the necessary food production is far from achieved. Land use and agricultural management, based on **agroecological principles and practices**, offer sustainable alternative ways for environmental and socio-economic development in different territorial contexts.

Biopesticides are gaining increasing attention due to their potential to provide effective pest control while minimising environmental impact compared to conventional chemical pesticides. In Europe, there is growing interest in sustainable agricultural practices and reducing reliance on synthetic chemicals, making the future of biopesticides an important and relevant subject of discussion. This includes current trends, challenges, regulatory frameworks, and future prospects for biopesticides in the European context, providing valuable insights for researchers, policymakers, and industry stakeholders.

Regarding **weed management**, some promising studies have focused on finding alternative methods to control them. One popular area of research involves finding natural herbicidal compounds, particularly extracted plants, that are rich in secondary metabolites (Fig. 1).

Nonetheless, biopesticides have some limitations, such as reduced storage stability and sensitivity to environmental conditions. Additionally, they have a high production cost. However, the increasing demand for alternative solutions has made biopesticides a promising option. They are made from widely available raw materials with often less toxic biocompounds and, when closely associated with more sustainable and

¹ Duarte, D., Gaspar, C., Galhano, C., Castro, P. 2021. Biopesticides and Sustainability in a Land Use Context. In: Leal Filho, W., Azeiteiro, U.M. and Setti, A.F.F. (eds) Sustainability in Natural Resources Management and Land Planning. World Sustainability Series. Springer, Cham. https://link.springer.com/chapter/10.1007/978-3-030-76624-5_8.

target-specific practices, reduce potential residues. With continuous research, the formulation can be improved to increase and maintain the biopesticide activity, which can be a solution to overcome these limitations.

Even though there are various incentives available, we are currently facing uncertain times. In June 2022, the Regulation on the Sustainable Use of Plant Protection Products was adopted. The aim was to reduce the use and risk of chemical pesticides by 50% by 2030 through implementing environmentally friendly pest control and to ban all pesticides in sensitive areas (e.g., public parks, gardens, playgrounds, sports grounds, or protected Natura 2000 areas). Nonetheless, in February 2024, the European Commission withdrew this proposal following farmer strikes across Europe. This raises some questions about future research in biopesticides and green alternatives. Does this mean there is a greater need to find low-cost, low-time-consuming solutions to control weeds and other undesirable organisms? Or will this slow the search for alternatives since there is no longer a stricter target to reduce chemical pesticide usage? Integrated agroecological practices with more environmentally friendly weed control bioherbicides align with the principles of **GOOD**, balancing agricultural productivity with environmental stewardship. This ultimately ensures food security while safeguarding ecosystems for future generations.

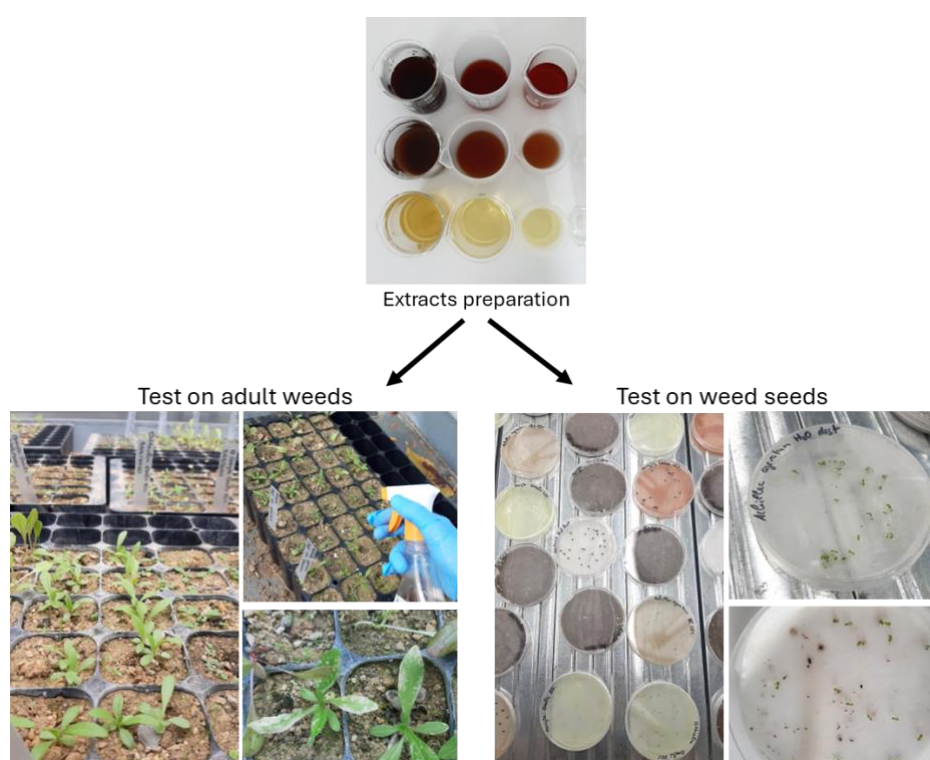


Figure 1. Analysis of plant extracts effects on weed germination and plant growth. Once a plant is selected, extracts are obtained and may be characterised to better understand their chemical composition. These are then applied to seeds and/or adult weeds to analyse the impacts on germination in adult plants. Concentration and the balance between non-ecotoxicological effect and efficacy are relevant points to study (Duarte et al., 2023²).



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² Duarte, D., Galhano, C., Dias, M.C., CastAro, P., & Lorenzo, P. 2023. Invasive plants and agri-food waste extracts as sustainable alternatives for the pre-emergence urban weed control in Portugal Central Region. *International Journal of Sustainable Development & World Ecology*, 30: 605–619. <https://doi.org/10.1080/13504509.2023.2175737>.