
EVALUATION OF THE ENVIRONMENTAL FATE AND IMPACT OF BIOPESTICIDES USING AN INNOVATIVE APPROACH COUPLING HIGH-THROUGHPUT METHODS

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Résumé

Biopesticides are complex substances that are derived from natural sources (e.g., plants, animals, microorganisms), and recently offer a promising alternative to traditional pesticides, but it is still unknown how long biopesticides and their residues remain in the environment then how long they impact organisms living in soil (prokaryotic and microeukaryotic species). In this context, we conducted an experiment to evaluate the environmental fate and impact of Beloukha, a bioherbicide containing Pelargononic acid as active substance. A kinetics study was performed over 57 days in soil microcosms comparing treated and non-treated conditions. The samples were analyzed using high-throughput omics techniques (metabolomics UHPLC-HRMS and 16S and 18S rRNA gene metabarcoding).

Thanks to the metabolomics data (14549 metabolites), we could determine the dissipation time. It corresponds to the time required for the dissipation of the biopesticides compounds (i.e. the Beloukha extract with the formulating agents). For that, a statistical method was developed which uses the occurrence and the intensities of each metabolite throughout the kinetics. It allowed the separation of the soil metabolites and the by-products from the biopesticide compounds. Then, through kinetic modeling using generic exponential degradation function, we found that 99% of the biopesticide compounds exhibit a half-life below 38 days.

Metabarcoding analyses revealed biodiversity changes over time (with alpha and beta diversity) as well as the impact of the biopesticide and its degradation products on bacteria. In particular, we found that bacterial assemblages were only impacted at the first-time

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steps of the experiment. Moreover, correlation analyses revealed high correlations between biopesticide compounds and bacteria genera that play important roles in plant growth, plant hormones regulation and azote fixation, (Anaeromyxobacter, Mycobacterium and Rhodococcus).

In essence, this work establishes a robust workflow applicable for studying the dissipation of biopesticides in the environment and determining their profound impact on biodiversity, The findings contribute valuable insights into the ecological implications of pesticides, paving the way for safe and sustainable pest management practices.

Mots-Clés: Biopesticide, Ecology, Metabolomics, Metabarcoding, Biostatistics, Bioinformatics, Bacteria