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HERBICIDE UPTAKE AND DISTRIBUTION IN OCIMUM BASILICUM

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Introduction

At the global level, the widespread use of synthetic herbicides—particularly auxinic compounds—has raised increasing environmental concerns due to their persistence, mobility, and potential ecotoxicological effects. Clopyralid and Picloram, two widely used synthetic auxins, are frequently detected in agricultural soils and water bodies, even at considerable distances from their application sites. Their continuous input into the environment through agricultural runoff and soil leaching has been linked to biodiversity loss, water quality degradation, and potential health risks associated with food contamination.

In Romania, despite growing awareness of pesticide-related environmental issues, limited data are available on the accumulation and behavior of synthetic auxins in edible or medicinal plants. Basil (*Ocimum basilicum*), a commonly cultivated aromatic species, is frequently grown in both rural and urban gardens and may act as a vector for transferring herbicide residues to consumers. The lack of national studies regarding the uptake and distribution of Clopyralid and Picloram in such plants restricts our ability to assess ecological impacts and implement science-based regulatory measures.

To address this gap, the present study investigates the absorption, translocation, and accumulation of Clopyralid and Picloram in basil plants exposed to contaminated soils under controlled conditions. By applying a validated LC-MS/MS method and calculating key ecotoxicological indicators such as the bioconcentration factor (BCF) and translocation factor (TF), the research aims to evaluate the plant's ability to retain or exclude synthetic auxins. These findings contribute to the broader understanding of herbicide behavior in food plants and offer valuable insights for sustainable agricultural practices and environmental protection strategies.

Materials and methods

Three 15-day exposure experiments were conducted using basil plants grown in soils contaminated with either Clopyralid, Picloram, or a mixture of both (100 µg/kg d.w.). Samples from roots, stems, and leaves were collected at regular intervals. Synthetic auxins were extracted via ultrasound-assisted extraction and quantified by LC-MS/MS using an optimized MRM method. Bioconcentration (BCF), root concentration (RCF), and translocation (TF) factors were calculated to evaluate the movement of herbicides within plant tissues.

Results and conclusions

The experimental results demonstrated that both Clopyralid and Picloram were absorbed by basil plants over the 15-day exposure period, though with significantly different distribution patterns. Clopyralid was detected in all plant organs—roots, stems, and leaves—while Picloram was mostly retained in the roots and detected only sporadically in the stems. No morphological symptoms or visible signs of toxicity were observed in any of the basil plants, even at relatively high exposure concentrations (100 µg/kg d.w.), suggesting a high tolerance under the tested conditions.

Clopyralid concentrations increased steadily in plant tissues, with the highest accumulation found in the leaves (up to 22 µg/kg d.w.), followed by roots and stems. In contrast, Picloram was largely restricted to roots, where its maximum concentration was 7.2 µg/kg d.w., and its presence in aerial parts was minimal or absent. These patterns indicate a differential behavior in uptake and mobility between the two compounds, potentially influenced by their physicochemical properties—such as water solubility, polarity, and affinity to root tissue.

Bioconcentration factor (BCF) values remained below 1 for both compounds, confirming that basil is not a bioaccumulator under the tested conditions. Nevertheless, Clopyralid exhibited notable upward mobility, as evidenced by translocation factor (TFl-s) values above 2, indicating preferential movement from stem to leaves. This finding raises concerns regarding the potential presence of herbicide residues in edible plant parts, especially since basil leaves are consumed fresh and untreated. Picloram, by contrast, exhibited low translocation values and was effectively retained in roots, showing poor systemic movement.

Interestingly, in experiments where Clopyralid and Picloram were applied together, Clopyralid exhibited enhanced accumulation in the leaves compared to individual exposure, suggesting a possible synergistic interaction in uptake or transport. This behavior may be due to root competition or altered permeability mechanisms triggered by co-contaminants. Such findings emphasize the complexity of plant-contaminant interactions, particularly under mixed pollution scenarios common in agricultural settings.

Overall, the study demonstrates that while basil is not suitable for phytoremediation of Clopyralid or Picloram due to low BCF and RCF values, it can accumulate detectable levels of Clopyralid in consumable tissues. This dual outcome—low remediation potential but high residue risk—highlights the need for stricter guidelines regarding herbicide application near edible or medicinal crops. Future research should expand on long-term exposure, metabolite formation, and human health implications associated with chronic dietary intake of herbicide residues in aromatic plants.

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