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Enhanced biodegradation of phenylurea herbicides in polluted soils using a combined bioagmentation and biostimulation technology

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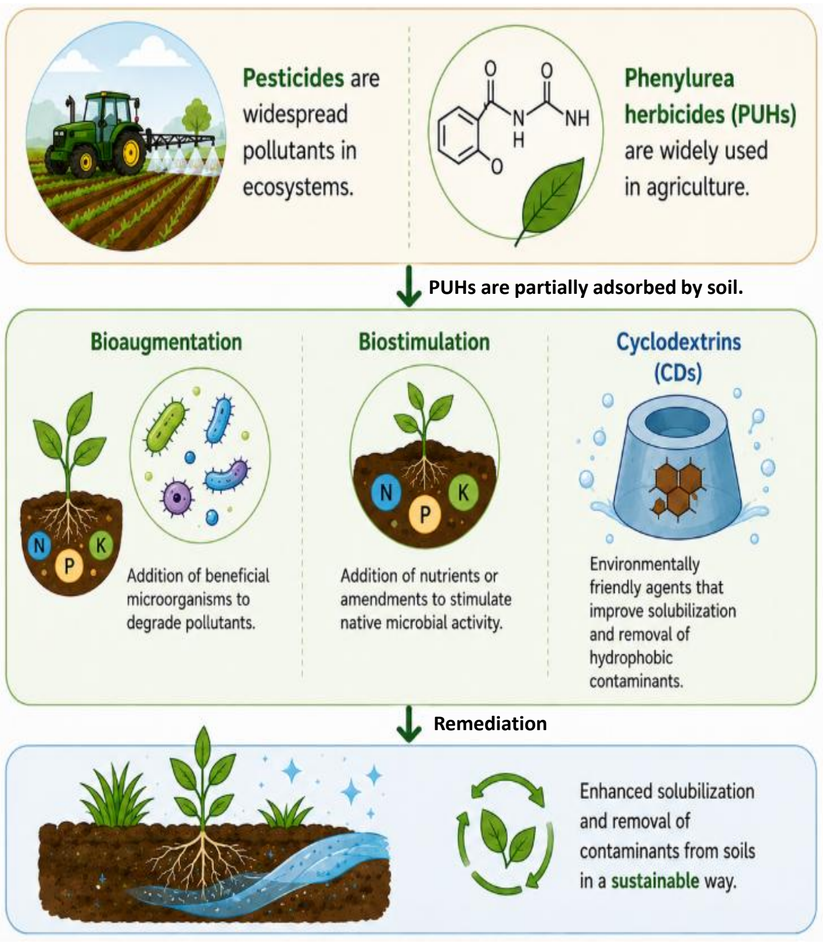
INTRODUCTION & AIM



The aim of this study was to assess the natural attenuation of two phenylurea herbicides (PUHs):

(chlorotoluron, CHL)
3-(3-chloro-4-methylphenyl)-1,1-dimethylurea

(isoproturon, ISP)
1,1-dimethyl-3-(4-isopropylphenyl)urea

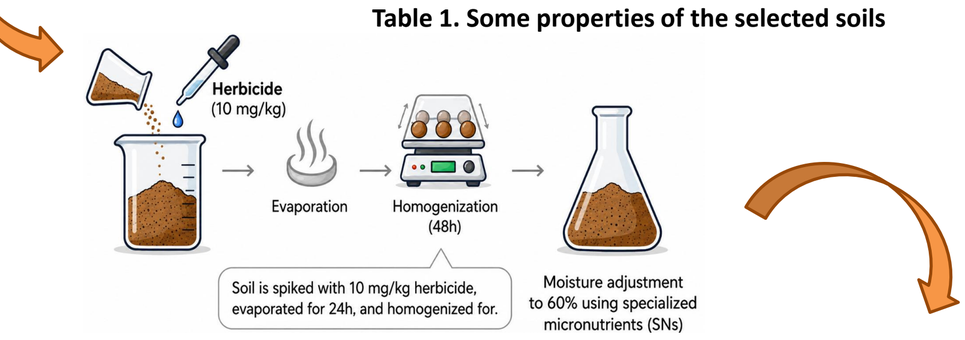
and the feasibility of using hydroxypropyl-β-cyclodextrin (HPβCD) or/and in combination with a PHU-s degrading bacterial consortium (BC) in three contaminated soils at an initial concentration of 10 mg kg^{-1}.

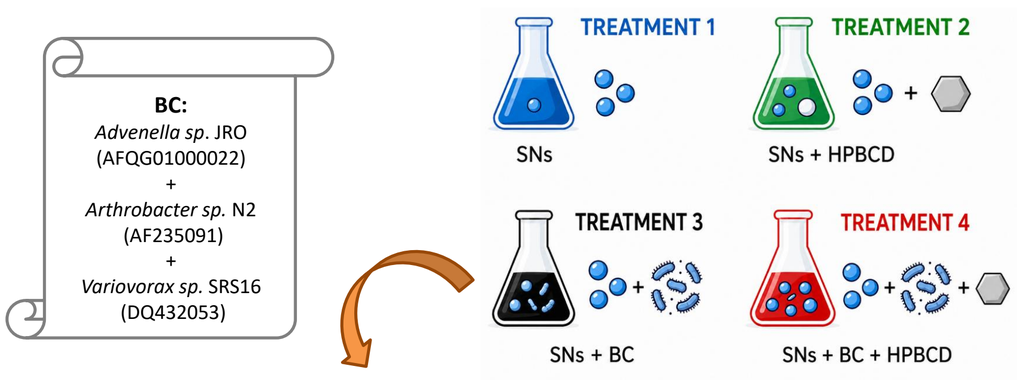
In this way, we intend to confirm whether the satisfactory results previously obtained in solution tests could be effectively transferred to soil conditions at contaminated sites.

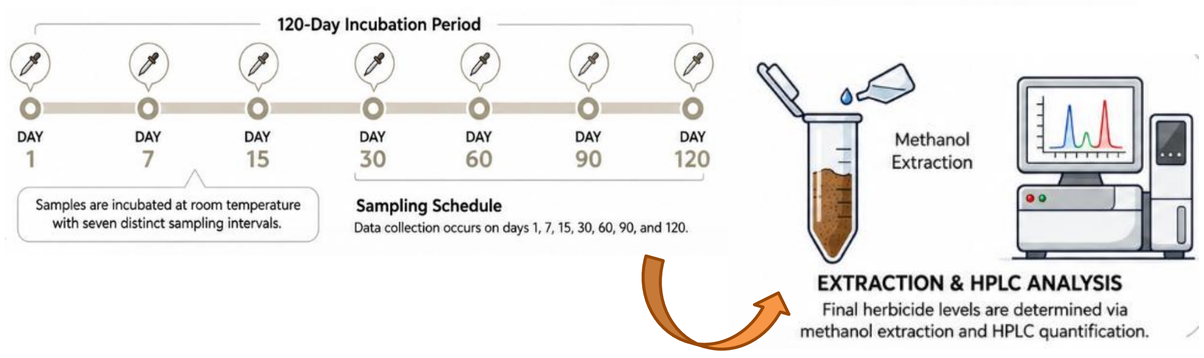
METHOD

Soil	pH	CO_3^{-2} (%)	OM (%)	CEC ($cmol_cKg^{-1}$)	Water holding capacity (%)	Sand (%)	Silt (%)	Clay (%)	Texture
I	7.93	1.1	1.91	7.54	33.8	50.4	39.3	10.2	Loam
II	7.85	3.6	0.63	3.22	26.5	90.4	6.5	3.0	Sand
III	7.46	3.9	3.04	8.11	19.7	64.8	23.8	11.4	Sandy Loam

Table 1. Some properties of the selected soils







RESULTS & DISCUSSION

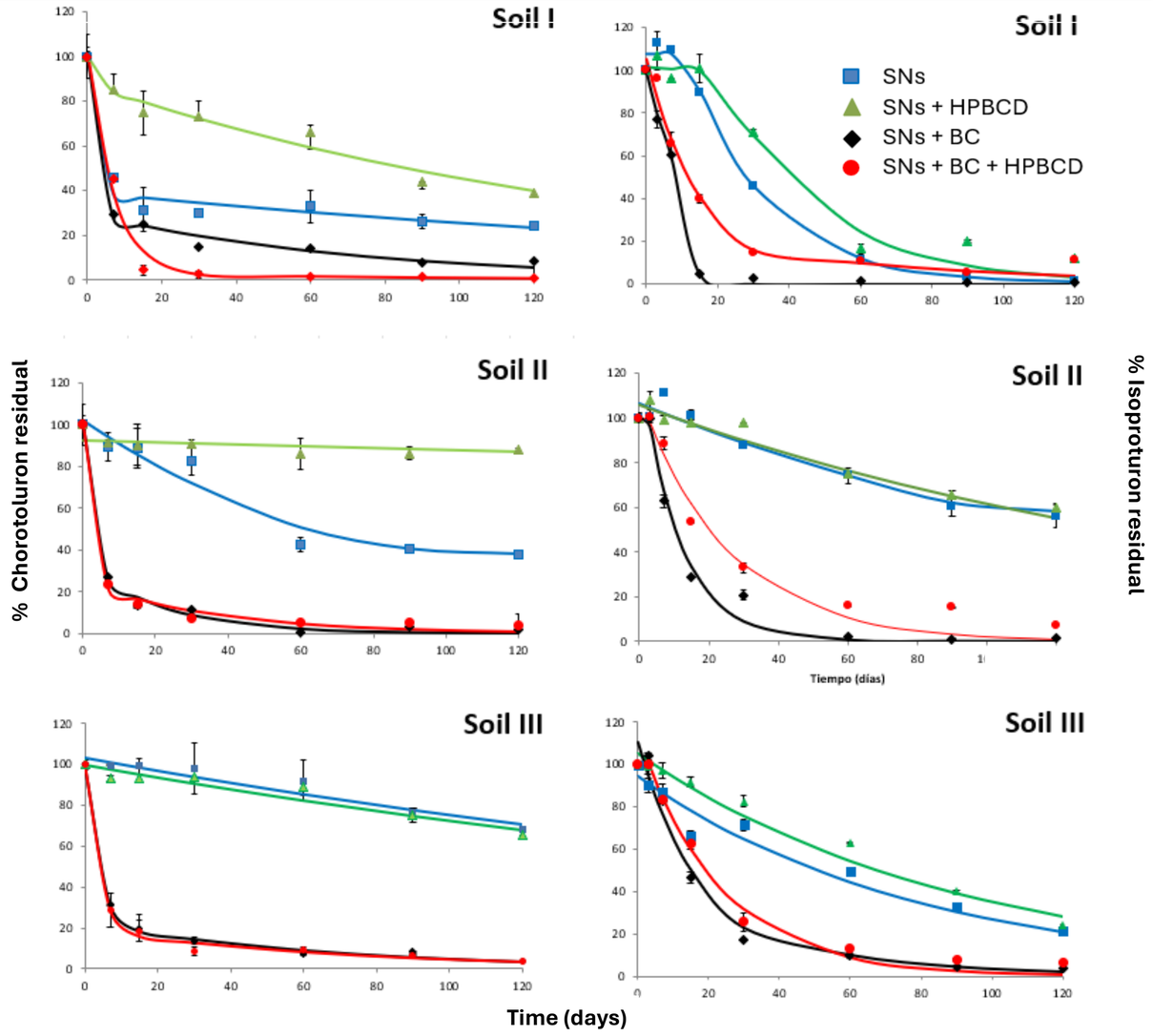


Figure 1. Biodegradation curves in soil I, II and III.

SOILS	TREATMENTS	DT_{50}		% BIODEGRADATION	
		CHL	ISP	CHL	ISP
I	SNs	2	26	76.55	99.23
	SNs + HPBCD	85	39	60.45	96.99
	SNs + BC	1	8	94.47	100
	SNs + BC + HPBCD	5	11	99.29	96.16
II	SNs	59	160	62.00	41.94
	SNs + HPBCD	1507	128	12.72	44.81
	SNs + BC	2	10	99.86	100
	SNs + BC + HPBCD	1	21	99.14	98.92
III	SNs	216	55	29.58	79.24
	SNs + HPBCD	217	63	32.19	72.17
	SNs + BC	4	13	96.28	98.17
	SNs + BC + HPBCD	4	19	94.46	99.32

Table 2. Kinetic parameters obtained from the modeling of the biodegradation curves of the herbicides. DT50: the time required for the concentration to decline to half of the initial value.

The three soils showed natural bioremediation capacity:

CHL degradation ranged from 29.6 to 76.6%, whereas ISP ranged from 41.9 to 99.2%. These rates were improved by using the BC increasing degradation (CHL: 94.4-99.9%; ISP: 98.2-100%).

Reductions in biodegradation rates were recorded when using HPβCD (CHL: 12.7-60.4%; ISP: 44.8-97.0%). When BC and HPβCD were used simultaneously, no improvement was observed compared to using only BC.

CONCLUSION

It can be concluded that BC constitutes an effective consortium for the biodegradation of multiple PUHs in contaminated soils, without requiring the addition of HPβCD to enhance the solubility or bioaccessibility of these compounds.

FUTURE WORK / REFERENCES

Enzymatic activity assays and toxicity studies will be conducted.

Morillo, E.; Madrid, F.; Lara-Moreno, A.; Villaverde, J. Soil bioremediation by cyclodextrins. A review. *Int. J. Pharm.* 2020, 591, 119943. https://doi.org/10.1016/j.ijpharm.2020.119943