The conservative tracer bromide inhibits pesticide mineralisation in soil

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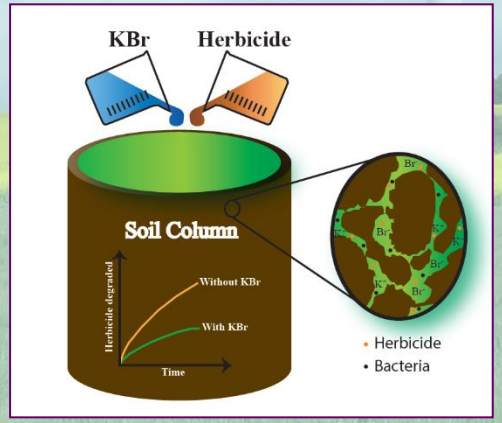
Bech et al. (2017), Envi. Pol. 222, 404-411

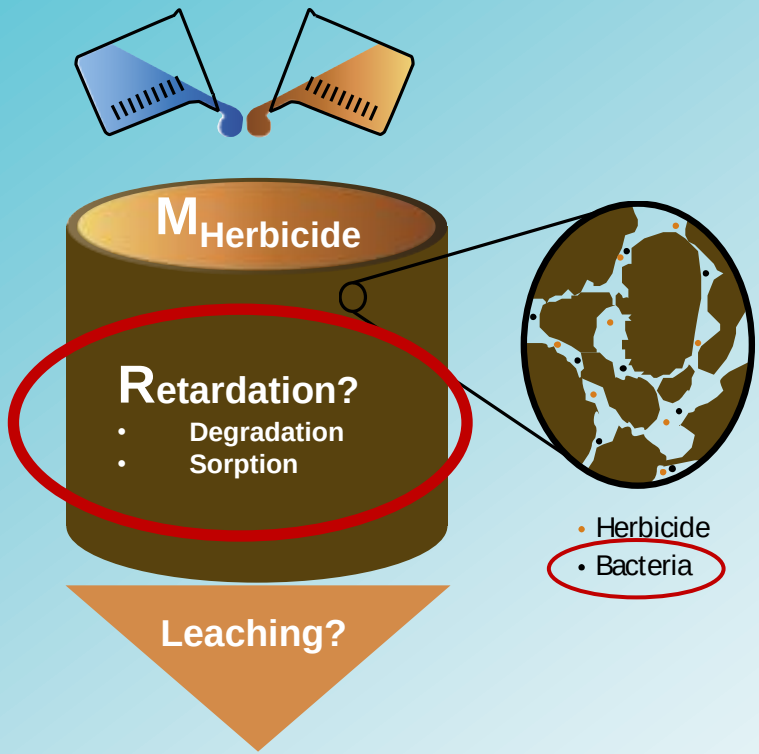


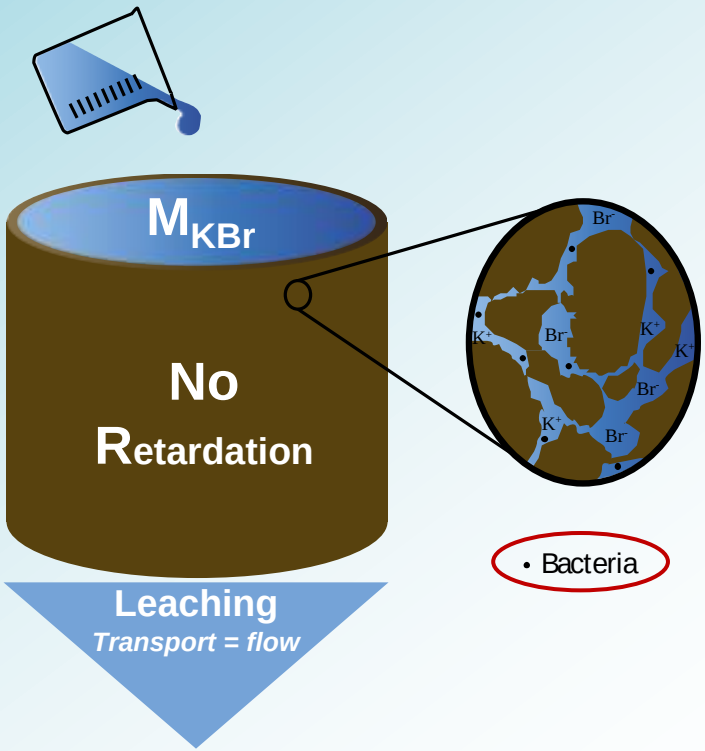
GEUS

Why?

Growth of a single-celled organisme can be inhibit at bromide concentrations ranging from 0.11 to 4.6 g L^{-1} *Flury and Papritz (1993), Envi. Pol. 222, 404-411*

Microbial degradation of pesticide is generally high in the topsoil – unfortunately, this is also where the highest bromide concentrations occur in leaching experiments





The bacterial functionality needs to be investigated!

Experimental setup

MCPA
- *Easily degraded*
- *Weak sorption*

Glyphosate
- *Medium degraded*
- *Strong sorption*

Metribuzin
- *Slowly degraded*
- *Weak sorption*

0, 0.5, 2.5 and 5 g Br^- L^{-1}

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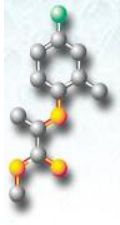
0, 0.5, 2.5 and 5 g Br^- L^{-1}

Soil	OM [%]	Clay [%]	Silt [%]	Sand [%]	Gravel [%]	pH_{CaCl_2}
Sandy loam	3.35	4.54	22.50	70.80	2.16	5.95
Loam	3.57	7.91	32.02	58.25	1.82	5.71
Loamy sand	3.93	2.76	14.84	82.24	0.15	5.49
Sand	3.83	1.18	6.58	91.32	0.93	5.81

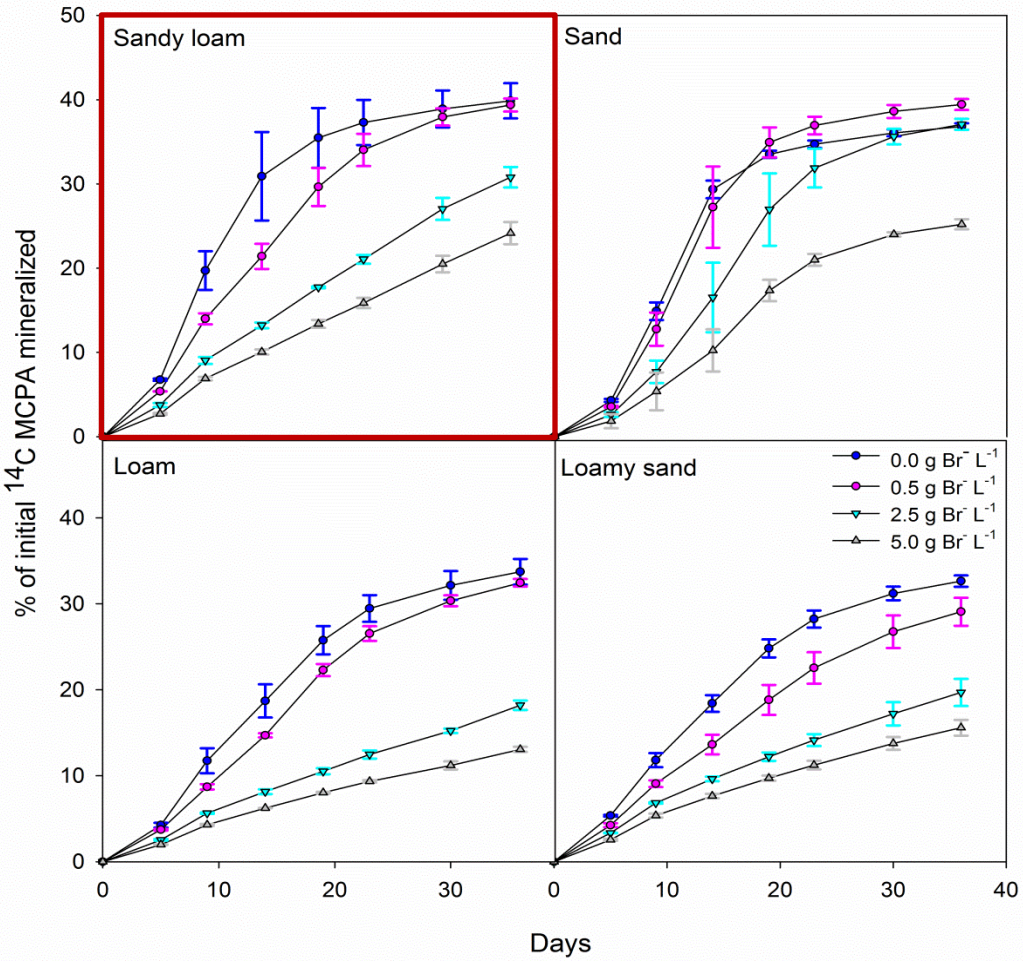
- Mineralisation experiments
- Sorption experiments *(Only for 5 g Br^- L^{-1})*
- DNA and RNA extraction *(Only for 5 g Br^- L^{-1})*
  - 16 S Miseq amplicon sequencing



Mineralisation and sorption of MCPA

Effect on mineralisation

- Decrease in the high potential for mineralisation (31-43%)
- Only bacterial growth at the low bromide conc.
- Significant effect of KBr treatment to 0.25 g Br^- L^{-1} in sandy loam



Effect on sorption

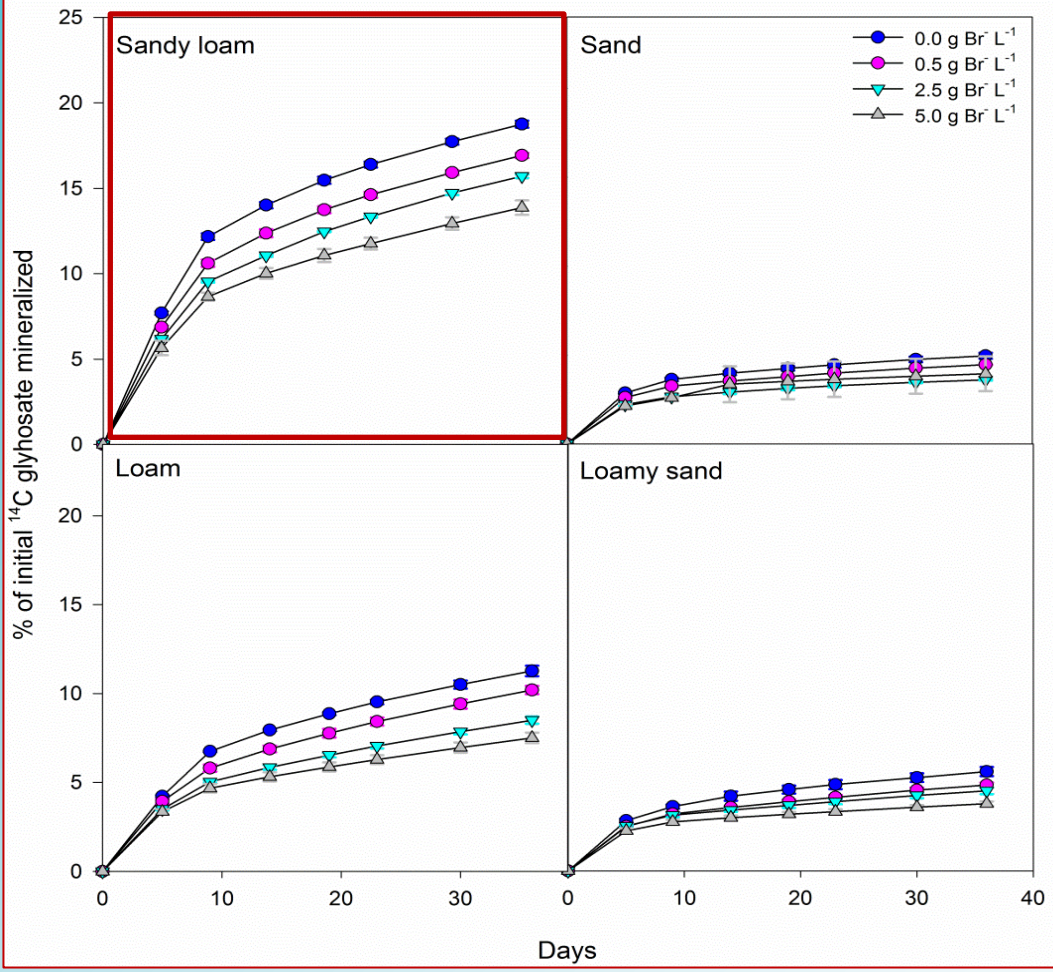
- Minor increase in the initial low sorption

Soil	Kd [mL g^{-1}]	
	$-Br^-$	$+Br^-$
Sandy loam	0.2	0.3
Loam	0.3	0.4
Loamy sand	0.6	0.8
Sand	0.6	0.7

Mineralisation and sorption of glyphosate

Effect on mineralisation

- Decrease in the low potential for mineralisation (5-18%)
- Highest inhibition in the loamy soils
- Significant effect of KBr treatment to 0.0625 g Br^- L^{-1} in sandy loam



Effect on sorption

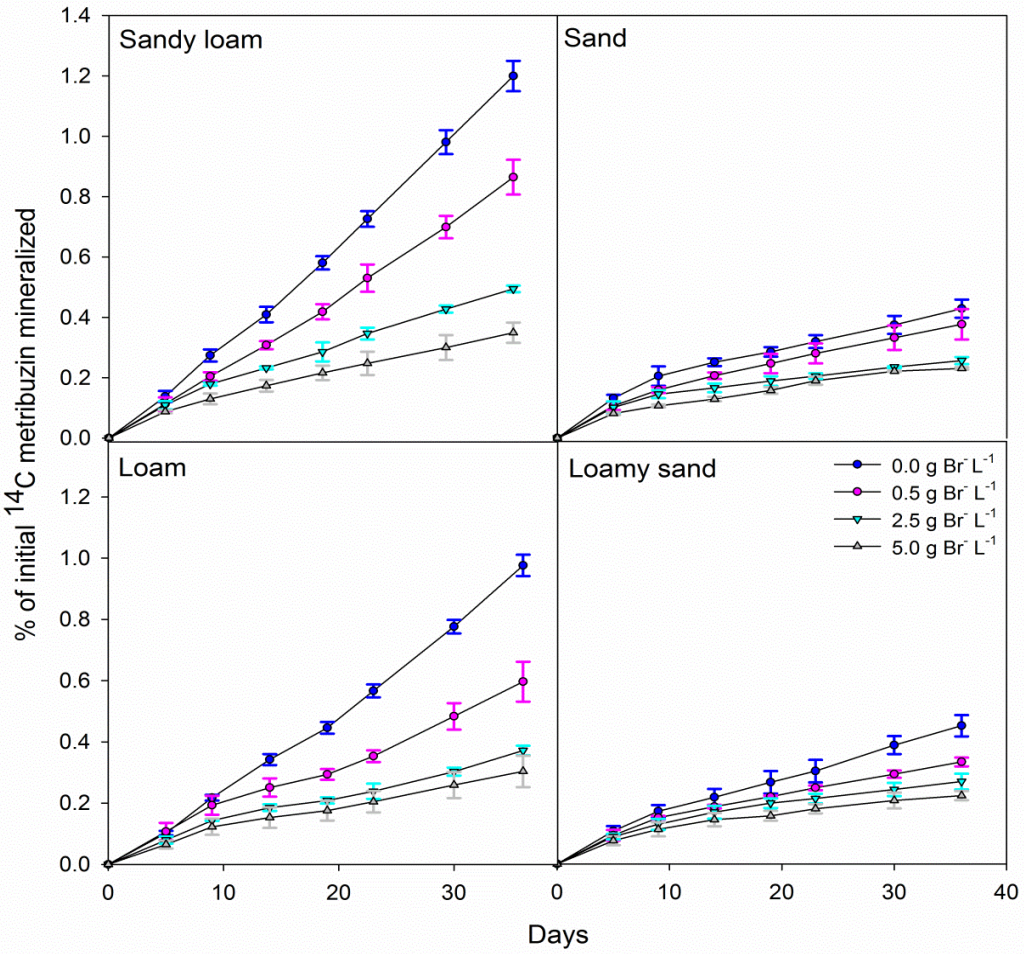
- Minor increase in firmly adsorbed glyphosate

Soil	Kd [mL g^{-1}]	
	$-Br^-$	$+Br^-$
Sandy loam	31.7	32.4
Loam	50.0	49.7
Loamy sand	38.4	46.0
Sand	31.6	35.7

Mineralisation and sorption of metribuzin

Effect on mineralisation

- Decrease in the low potential for mineralisation (0.4-1.2%)
- Highest inhibition in the loamy soils
- Mineralisation below purity of ^{14}C labelled metribuzin



Effect on sorption

- Minor increase in sorption of the loamy soils

Soil	Kd [mL g^{-1}]	
	-Br$^-$	+Br$^-$
Sandy loam	0.7	0.8
Loam	0.8	0.9
Loamy sand	1.0	1.0
Sand	1.0	1.0

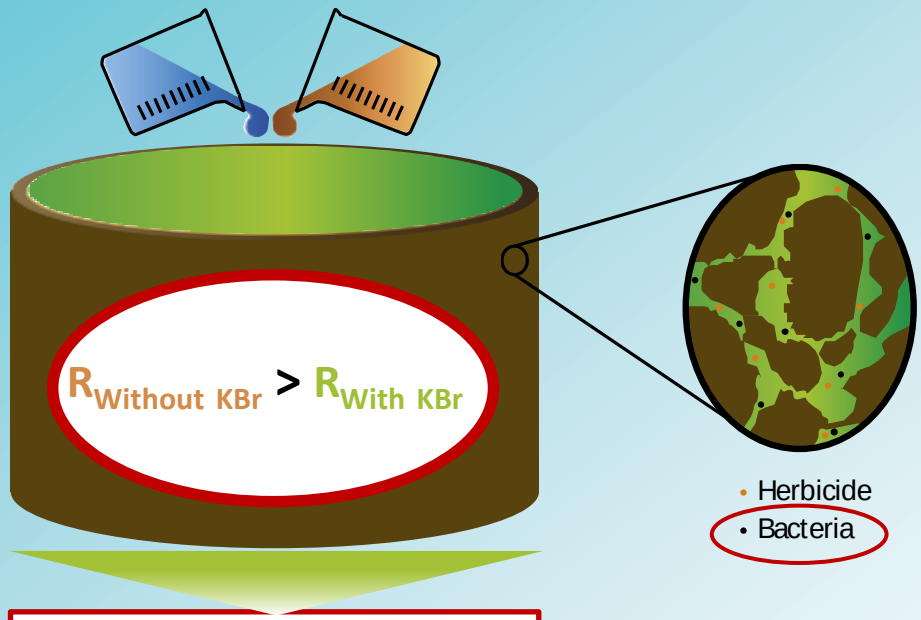
OTU significantly affected by KBr

Soil	DNA (Orders)	OTU	Abundance [-]		RNA (Orders)	OTU	Abundance [-]	
			KBr	Control			KBr	Control
Sand	Sphingobacteriales	241	0.27	0.08				
		9599	0.29	0.06				
	Burkholderiales	**56**	0.03	0.16	Burkholderiales	**56**	0.19	1.36
					Xanthomonadales	129	0.04	0.27
Sandy loam	Flavobacteriales	**48**	0.03	0.8	Flavobacteriales	**48**	0.17	0.01
		13	0.10	0.92		**13**	0.25	0.04
		327	0.03	0.42				
		354	0.01	0.19				
		628	0.04	0.23				
		3987	0.38	0.94				
		5620	0.01	0.11				
		23	0.28	0.62				
	Sphingobacteriales	4182	0.00	0.17	Sphingobacteriales	4182	0.10	0.00
		289	0.01	0.17		241	0.25	0.00
		37	0.02	0.19		37	0.07	0.01
Loamy sand	Alteromonadales	**32**	0.03	0.21	Alteromonadales	**32**	0.07	0.38
					Alteromonadales	695	0.01	0.07
	Burkholderiales	**56**	0.00	0.04	Burkholderiales	**56**	0.01	0.22
	Bdellovibrionales	**604**	0.00	0.06	Bdellovibrionales	**604**	0.01	0.07
					Xanthomonadales	129	0.03	0.16
					Cytophagales	357	0.00	0.03
Loam	Flavobacteriales	48	0.01	0.21				
	Sphingobacteriales	241	0.01	0.31				
		37	0.05	0.49				
		39	0.09	0.78	Sphingobacteriales	**39**	0.04	0.38
		142	0.03	0.34				
	Cytophagales	964	0.04	0.19				

Increase

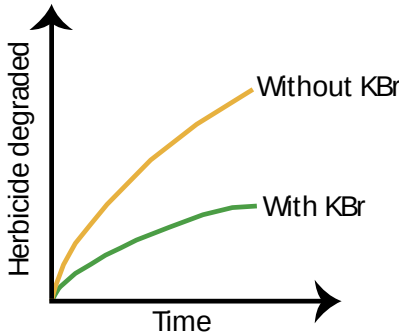
- Abundance of most species did not change significantly by the KBr treatments
- Few strains have been affected by KBr treatments
- Most of the affected strains decreased significantly in relative abundance of DNA and RNA OTUs
- The increase in abundance of Sphingobacteriales in sand could be due to growth on other lysed bacteria
- In three of the four soils a reduction was apparent in the presence and/or activity of an OTU related to *Proteobacteria* order *Burkholderiales*

Implications



Leaching < Leaching

Inhibit mineralisation



Minor increase in sorption, Kd

	MCPA	Glyphosate	Metribuzin
Sandy loam	0.1*	0.7	0.1*
Loam	0.1*	-0.3	0.1
Loamy sand	0.2*	7.6	0.0
Sand	0.1	4.1*	0.0

* Indicates a significant difference between the control and the KBr treatment < 0.05

Reduced abundance of:

bacteroidetes
proteobacteria

on both DNA and RNA level