CRC 1253 CATCHMENTS AS REACTORS CAMPOS

EBERHARD KARLS UNIVERSITÄT TÜBINGEN

Biodegradation of pesticides at the limit

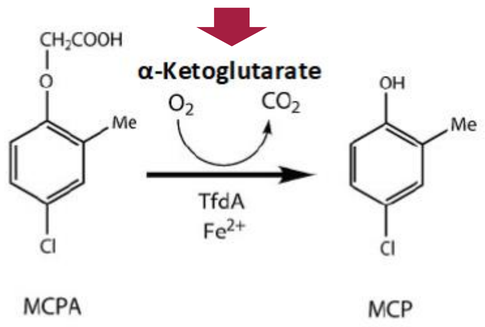
Hannes Wirsching[a]; Holger Pagel[b]; Franziska Ditterich[a]; Marie Uksa[a]; Luciana Chavez Rodriguez[b]; Martina Werneburg[c]; Ellen Kandeler[a]; Christian Poll[a]

Context

- **Multiple pesticides persist at low concentrations** in soils despite the general abundance of degrading organisms [1]
- Low pesticide concentrations matter because the **safety thresholds in the EU** for herbicides in drinking water is only **0.1 µg l^{-1}** [2]

Rate limiting step of MCPA degradation

functional gene *tfdA* encodes:

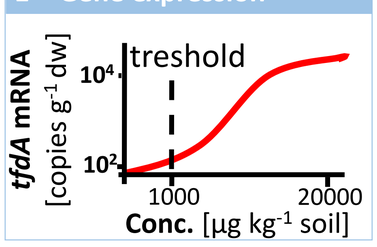


Highlights

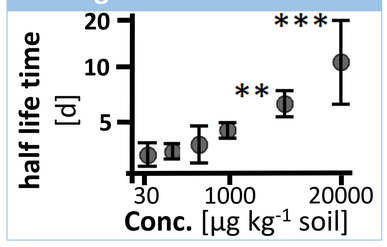
- **MCPA** degradation rates determined at higher concentration cannot be extrapolated to **lower concentrations**
- Degradation of MCPA took place **near the drinking water limit**
- **Data of functional gene** expression cannot explain the **persistence of low pesticide concentration in soils**

.. but first results confirm a concentration-dependent effect :

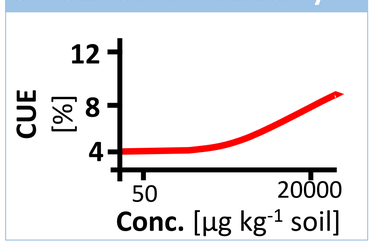
1 – Gene expression



2 – Degradation kinetics



3 – Carbon use efficiency



Research Questions

General research Question: What limits pesticide degradation in soils?

I. Are there pesticide concentration thresholds that limit functional gene expression?

II. Are degraders energy-limited at low pesticide concentrations?

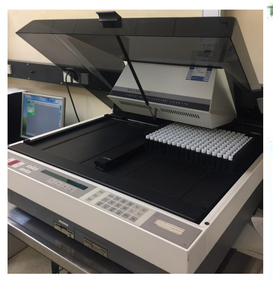
Material & Methods

Incubation experiment with increasing ^{14}C-labelled MCPA concentrations (0, 30, 50, 100, 500, 1000, 5000, 20000 µg kg^{-1} soil)

I. ^{14}C Analysis

Microcosm

- 50 g topsoil from a Luvisol (nearby Tübingen,Germany)
- Incubation for 4 weeks at 21°C

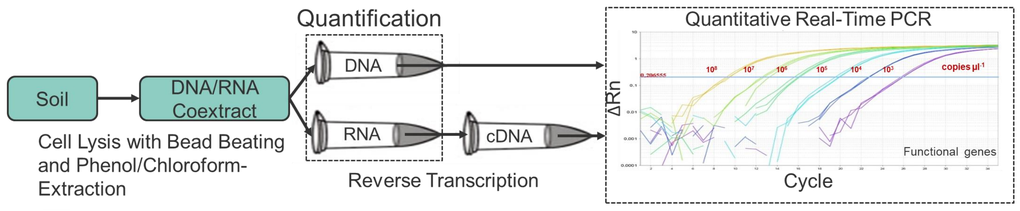


detection of ß-decay

^{14}C in microbial biomass C

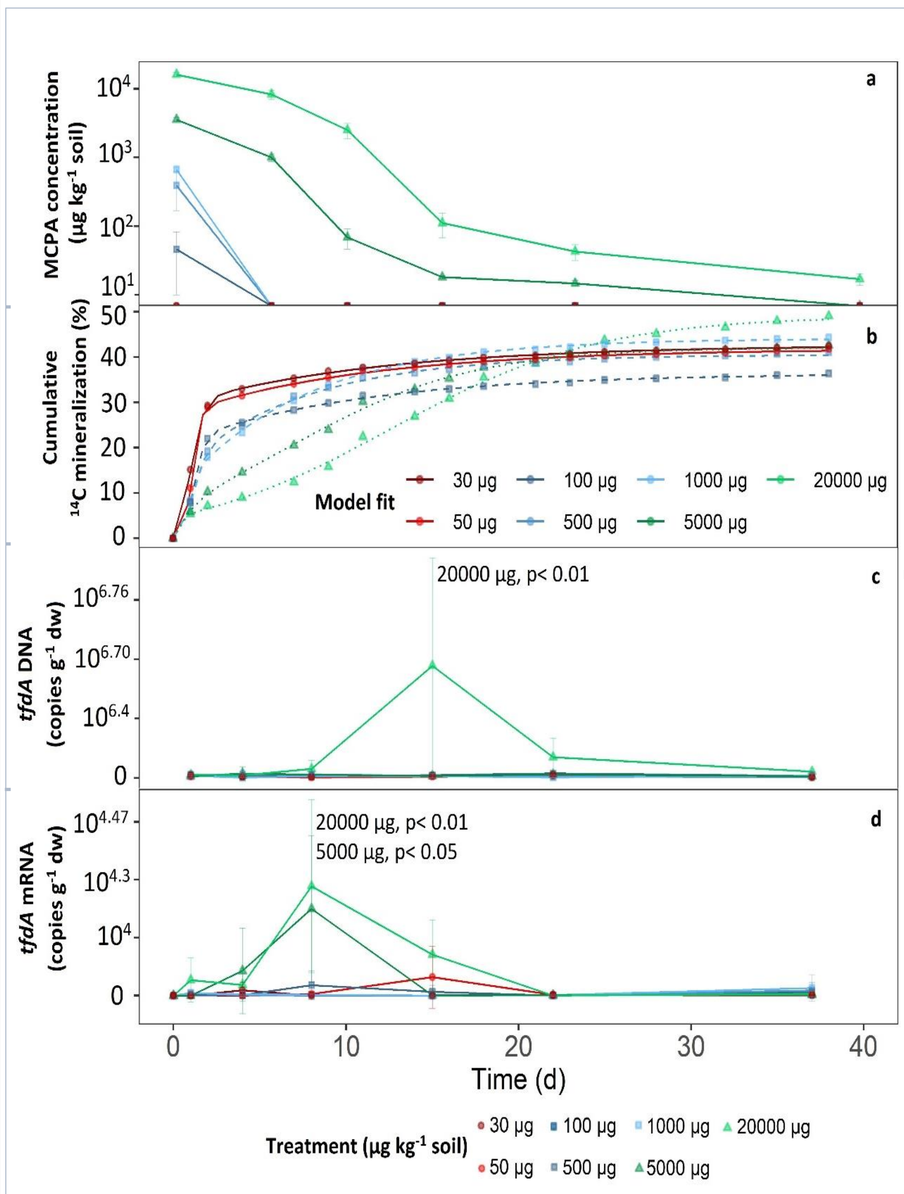
Follow mineralization of model compound via ^{14}C-CO_2 respiration

II. Molecular analysis of MCPA degradation in soil

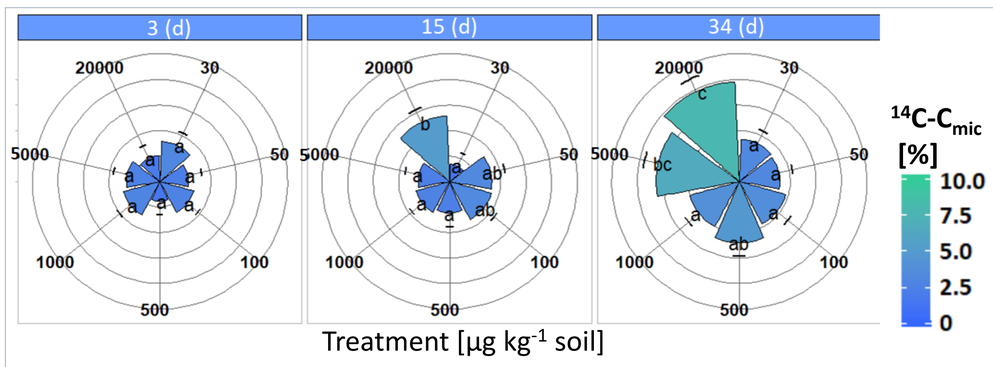


The quantity of functional genes (DNA) represents the potential of microorganism to degrade MCPA. The transcript abundance (RNA) reflects the activity of specific degraders.

Results & Discussion

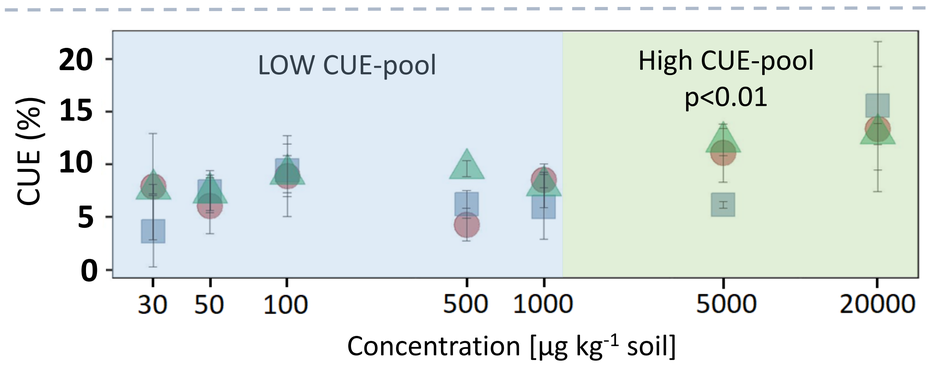


- ≥ 5000 µg inverted logistic decline for MCPA, rapid degradation concentration ≤ 5000 µg kg^{-1} soil
- Half life-time (5 – 14 d) is significantly higher for concentration ≥ 5000 µg kg^{-1} soil than for lower concentration (1 – 3 d)
- At low concentrations, the MCPA degraders are energy-limited and therefore an increase of the *tfdA* gene occurs (at a detectable level) only at high concentrations
- Only the concentration of 20000 µg kg^{-1} soil enables a significant increase of the degrading community



- Assimilation > 5000 µg kg^{-1} soil significantly higher ($p<0.05$) up to 8 %

→ **But even at low concentration microorganism use MCPA as an carbon source (2 ~ 3% incorporation) to growth which proves that it is not just a co-metabolic degradation**



→ **At low conc. (≤ 1000 µg, mean = 0.07 ± 0.005 se) energy limitation leads to catabolic use of MCPA shifting with increasing concentration (≥ 5000 µg, mean = 0.11 ± 0.009 se) towards an anabolic mineralization**

References:
[1] Miglioranza KB, Gonzalez Sagrario M, Aizpun de Moreno JE, Moreno VJ, Escalante AH, Osterrieth ML. (2002). Agriculture soil as a potential source of input of organochlorine pesticides into a nearby pond. Argentina: Environ Sci & Pollut Res 9 (4): 250 - 256.
[2] EU-guidelines 98/33/EG. (1998).

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