Objectives

How do pesticides sorb to matrix substrates?

How are pesticides retained and degraded when the factor transport is incorporated?

Can we improve pesticide degradation by the use of pesticide-primed material?

How do pesticides behave in the system under variable flux?
Spatial scale of the experiments

- **Laboratory studies**
  - Batch sorption experiments
  - Batch degradation experiments
  - Scale (m): 0.01

- **Field studies**
  - Micro scale columns
  - Macro scale columns
  - Pilot installations
  - Scale (m): 0.1
  - 1
Sorption isotherms

Peat mix
Garden waste
compost
Coco chips
Straw
Dried cow manure
Willow
chopping
Sandy loam soil

Sorption ≈ OC, CaO and CEC

Immobile pesticides
Linuron
Isoxaben
Lenacil

Mobile pesticides
Isoproturon
Metalaxyl
Bentazon
Transport in micro- and macrocosms: Experimental set-up

Microcosms

Macrocosms

Pesticide solution (isoproturon, linuron, bentazon, metalaxyl)

~ organic mixture

HPLC
Transport in micro- and macrocosms: Experimental set-up

- Influence of matrix composition
- Influence of inoculation with pesticide primed material
- Influence of variable flux
Influence of substrate composition

Mixture: 20% peat mix, 5% cow manure, 25% sandy loam soil, 50% straw
Matrix composition did not have a significant influence on pesticide leaching and degradation. However, the addition of cow manure enhanced degradation of some pesticides.

Sorption coefficients from batch experiments >> sorption coefficients from column experiments. **$K_{oc}$ value**: good indicator of mobility of the pesticide in the column.

**Monod kinetics** described BTC well ➔ decrease in effluent concentration related to biomass growth. A decrease in the soil fraction from 25% to 5% did not decrease the efficiency.
What is pesticide-primed material?

Soil never treated

Field soil treated with pesticide X

New biopurification system which treats pesticide X

No or limited specific pesticide degrading m.o. present

Increase specific pesticide degrading m.o. = pesticide-primed

Result: higher degradation + shorter start-up phase
Experimental set-up

Matrix consists of 45% peat mix and 50% straw
Does primed material enhance degradation?

No significant difference between isoproturon primed-non-primed soil (low initial isoproturon degrading capacity)

Enhanced degradation in the presence of metalaxyl-primed soil + also adaptation in isoproturon-primed soil
Matrix from a biopurification system in use or soil previously treated could be used as an *inoculation source*, as it significantly enhanced metalaxyl degradation.

This strategy could be used to **reduce the start-up phase** when the system is most vulnerable to leaching as the biomass has to be adapted and grow.

**Not valid** for isoproturon degradation ➔ soil treated too long ago? Loss of degradation capacity? Degradation restricted to a small group of organisms?
How do pesticides behave under variable flux?

Pesticides added: Metamitron, bentazone, metalaxyl, isoproturon, linuron

Low flux

Intermediate flux

High flux

Experimental set-up

Microcosms

Macrocosms

Matrix consists of 5% dried cow manure, 25% coco chips, 35% peat mix, 25% straw and 10% soil
How do pesticides behave under variable flux in microcosms?

- **Metalaxyl**: Shows a rapid initial decrease followed by a gradual increase, with higher concentrations at intermediate and high flow rates.
- **Bentazone**: Exhibits a more gradual decrease and increase, with minor variations at different flow rates.
- **Isoproturon**: Displays a similar trend to metalaxyl but with a narrower concentration range.
- **Metamitron**: Demonstrates a slower decrease and increase, with consistent differences across flow conditions.
How do pesticides behave under variable flux in macrocosms?

No breakthrough of linuron, isoproturon, metamitron
Flux has a significant influence on sorption and degradation.

**Sorption** of the intermediate mobile pesticides was significantly **lower at a higher flux**, as the sorption is time-dependent at high water fluxes. However, no influence of the studied fluxes on the immobile and very mobile pesticides.

A **decrease in degradation** was observed with **increasing flux** as the opportunity time decreases with increasing flux, or the higher pesticide input creates toxic levels, or a shift in the pesticide degrading biomass might occur.

The decrease in flux compared to the microcosms provoked a further significant **reduction in effluent concentration** and a significant reduction in the effluent concentration of the most mobile pesticide, **bentazone**.
General conclusion

1. Sorption coefficients determined in batch sorption experiments are often not suitable for describing solute transport at the column or field scale.

2. Matrix composition did not have a significant influence on pesticide leaching and degradation. However, the addition of cow manure enhanced degradation of some pesticides.

3. The use of pesticide-primed material enhanced degradation of metalaxyl significantly.

4. An increasing flux had a pernicious influence on sorption and degradation of the majority of the studied pesticides.
Thank you for your attention