UNIVERSITEIT GENT

SORPTION AND DEGRADATION OF PESTICIDES IN BIOPURIFICATION SYSTEMS

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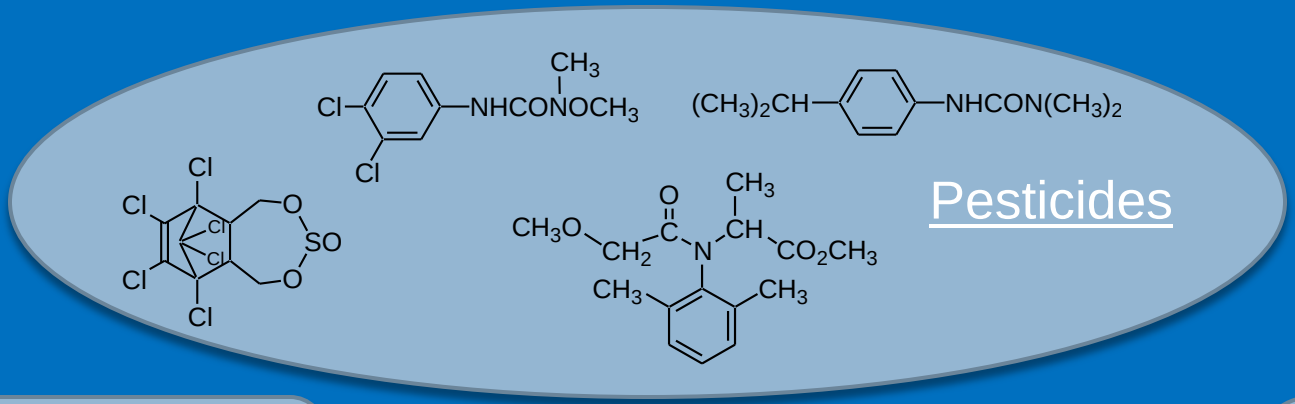
Objectives



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

Batch sorption experiments

Batch degradation experiments

Micro scale columns

Macro scale columns

Pilot installations

Laboratory studies

Field studies

Scale (m): 0.01 0.1 1 10

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

Isoproturon
Metalaxyl

Bentazon

Mobile pesticides

Transport in micro- and macrocosms: Experimental set-up

Pesticide solution
(isoproturon, linuron
bentazon, metalaxyl

~ organic mixture

HPL
C

Microcosms

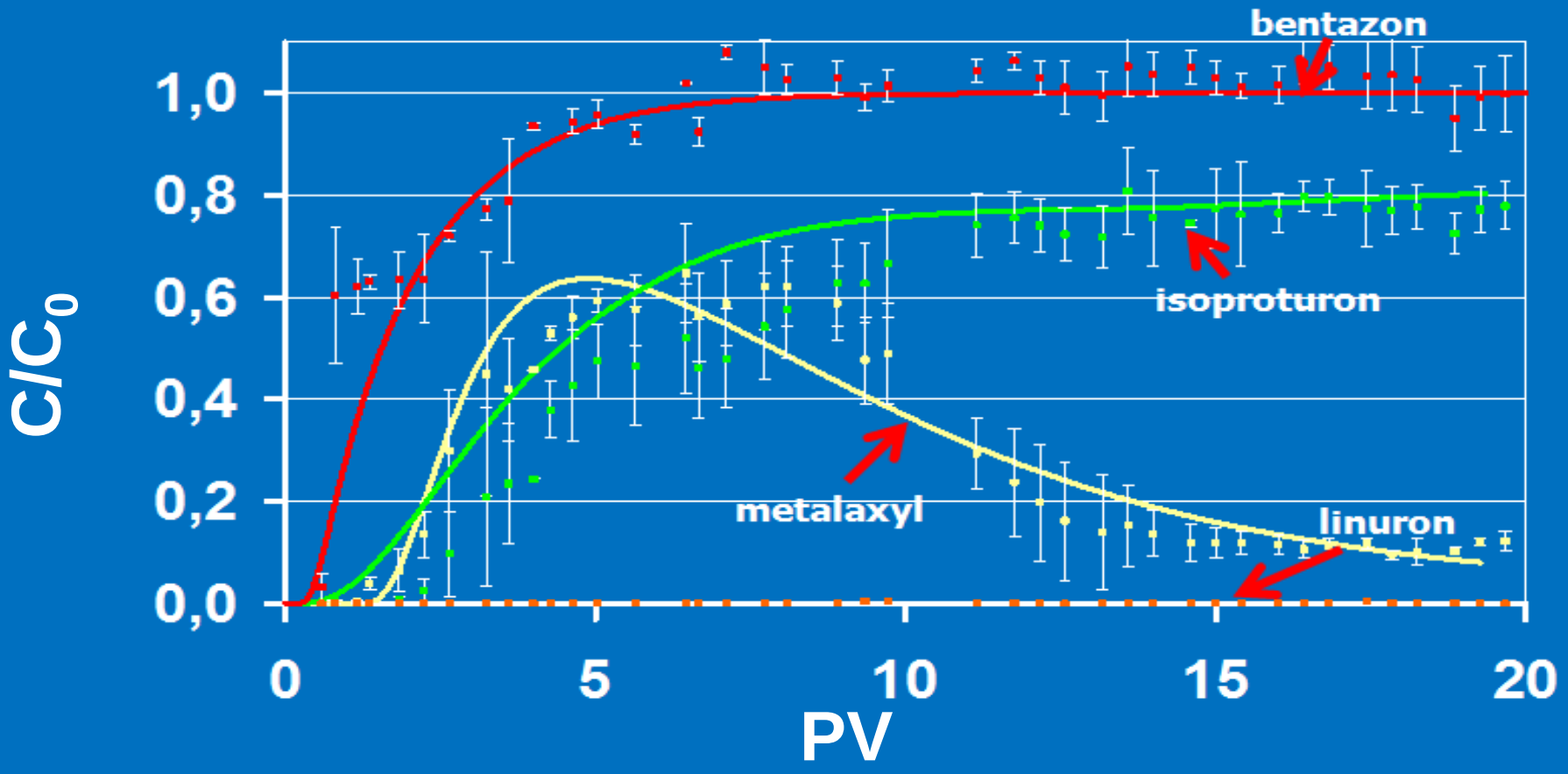
Macrocosms

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



Pesticide breakthrough curves: observations

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

No or limited specific pesticide degrading m.o. present

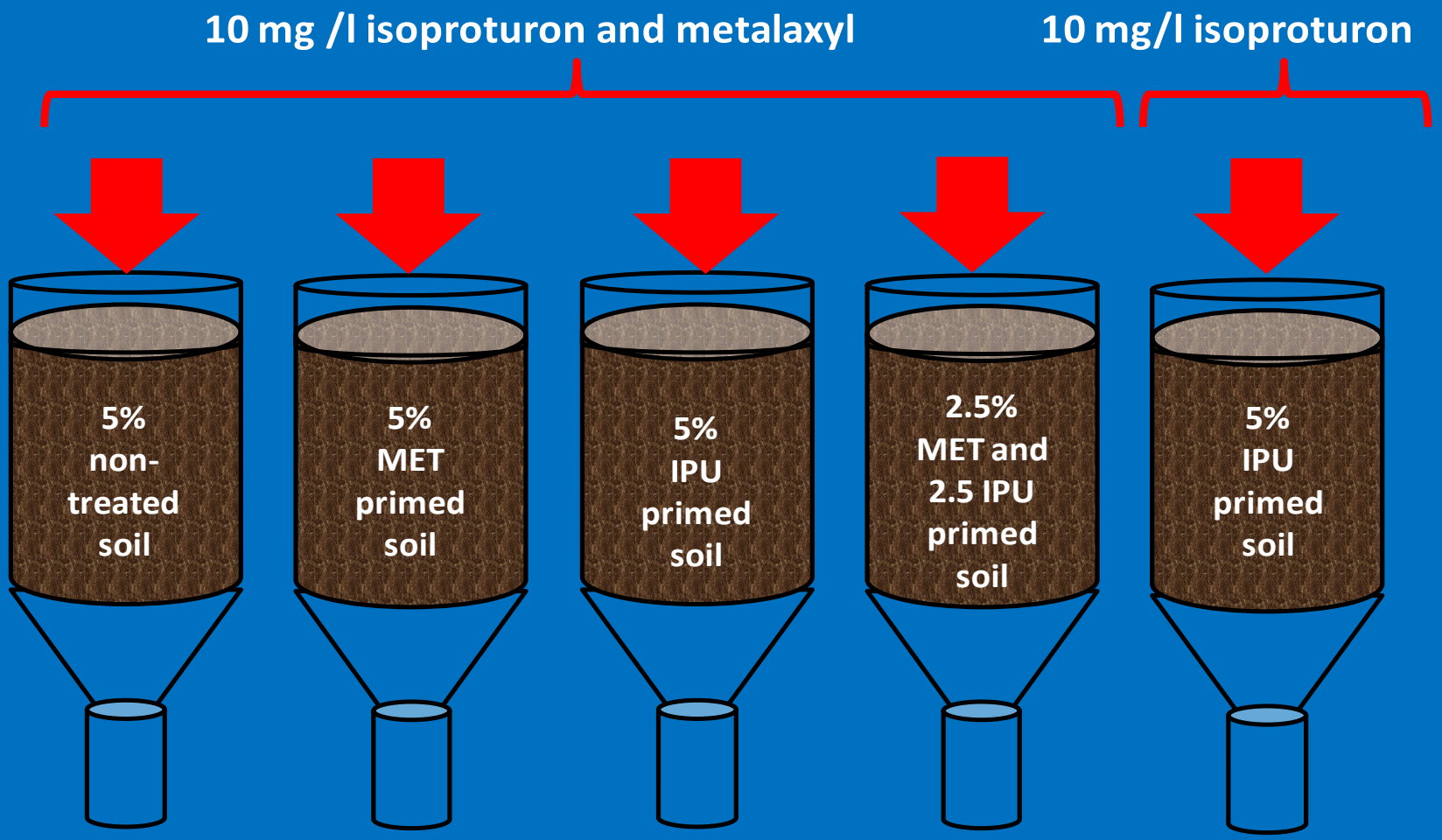
Field soil treated with pesticide X

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

New biopurification system which treats pesticide X

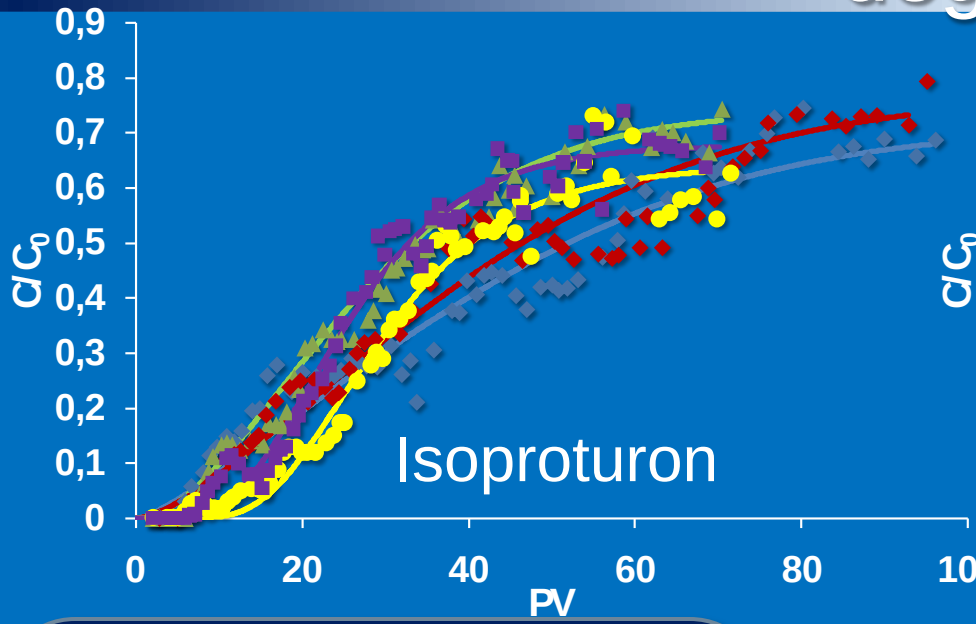
Result: higher degradation + shorter start-up phase

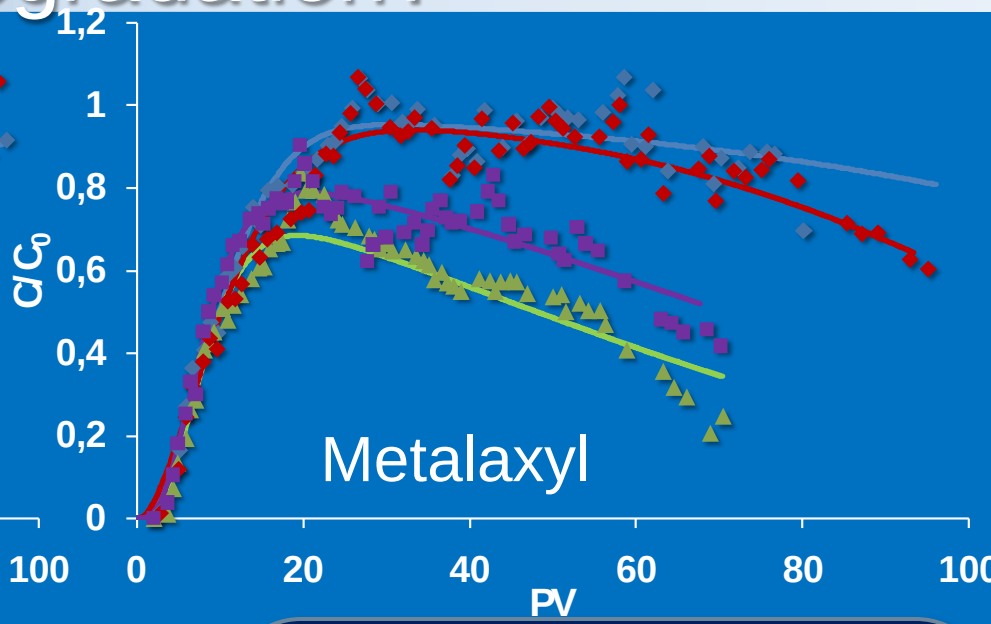
Experimental set-up



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)

- 5% non-treated
- 5% metalaxyl
- 5% isoproturon
- 5% isoproturon
- 2.5% metalaxyl-2.5% isoproturon

Enhanced degradation in the presence of metalaxyl-primed soil + also adaptation in isoproturon-primed soil

Primed material can enhance degradation

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?

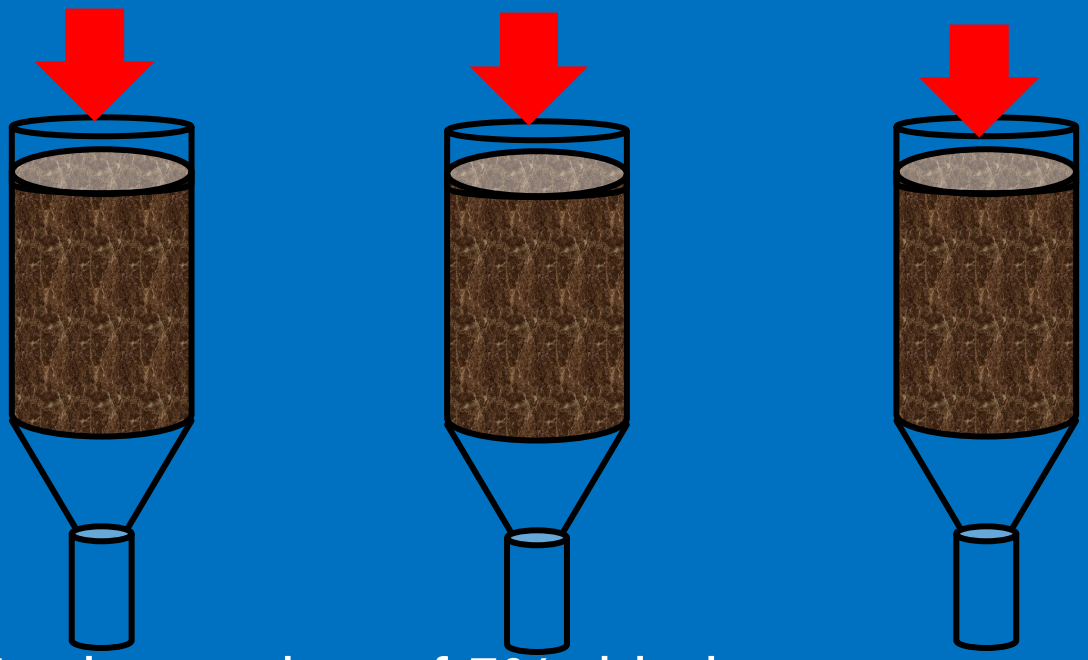
How do pesticides behave under variable flux?

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

Low flux

Intermediate flux

High flux



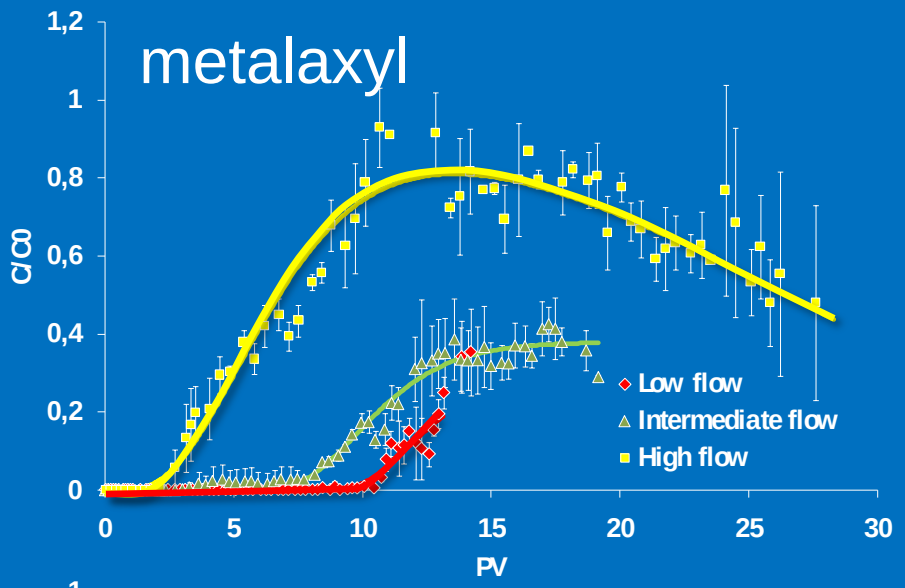
Experimental set-up

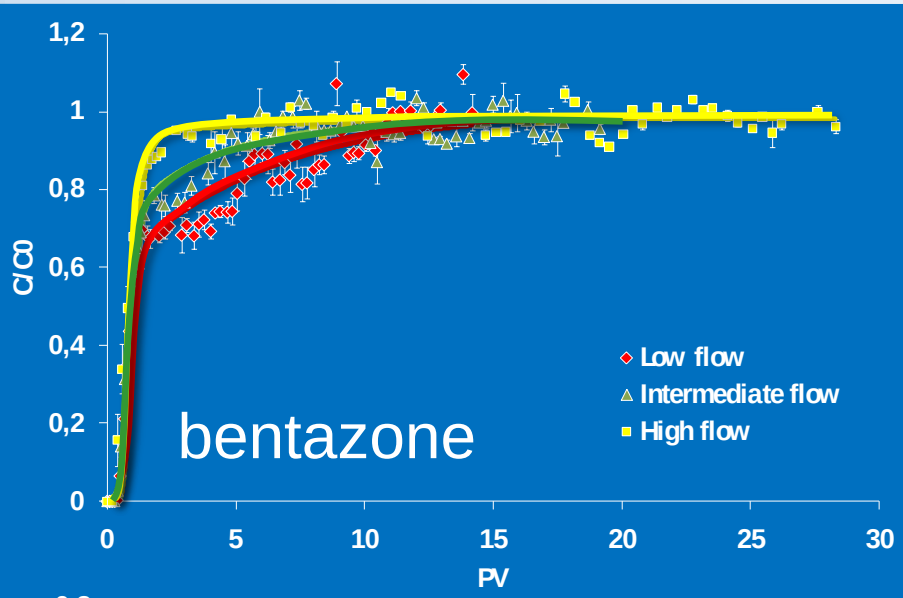
Microcosms

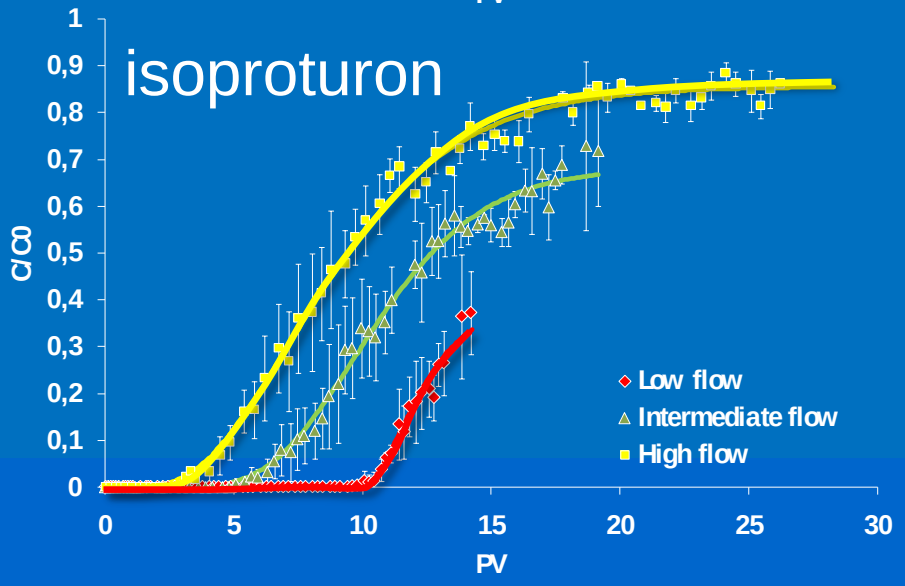
Macrocosms

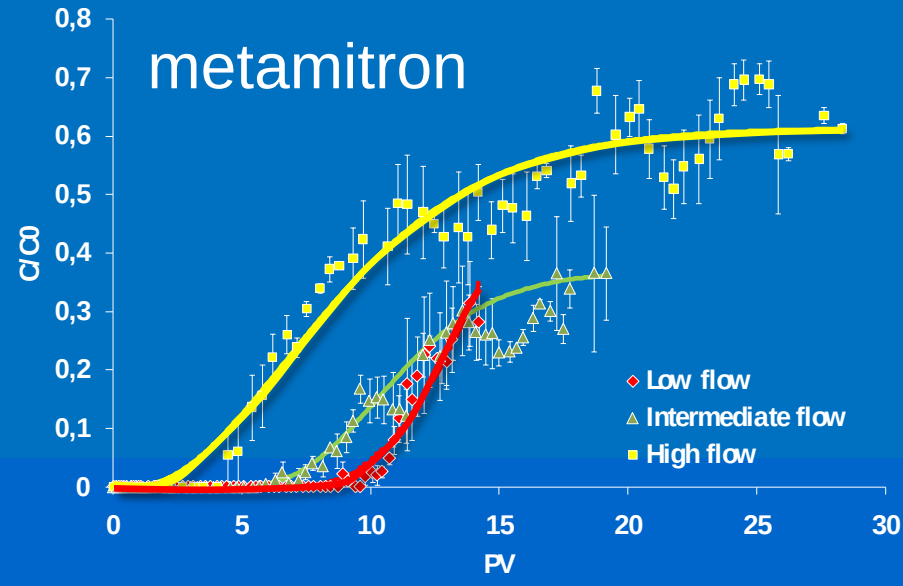
Matrix consists of 5% dried cow manure, 25% coco chips, 35% peat mix, 25% straw and 10% soil

How do pesticides behave under variable flux in microcosms?

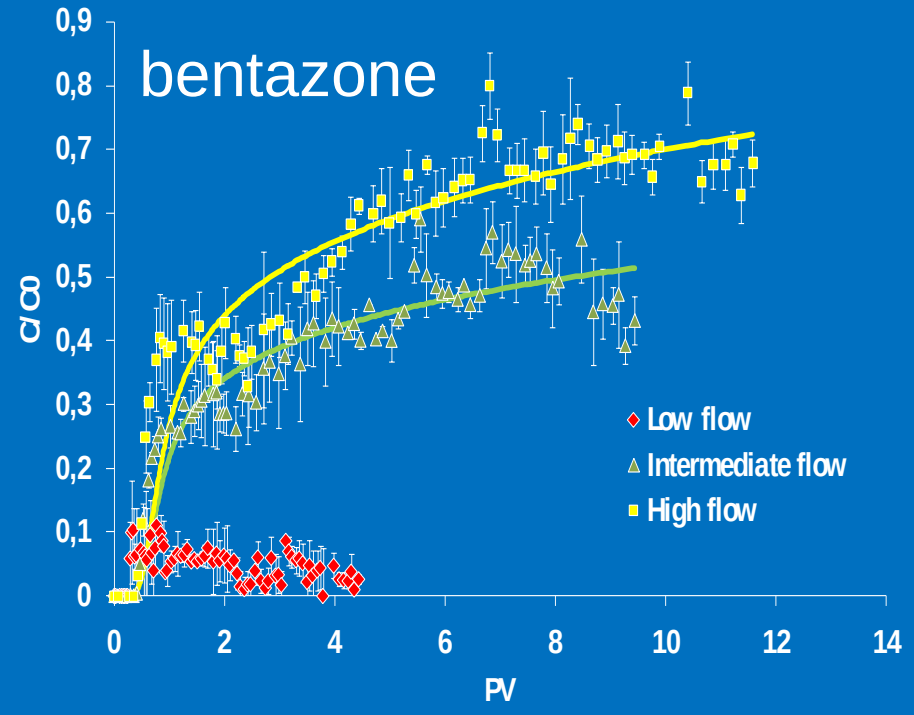


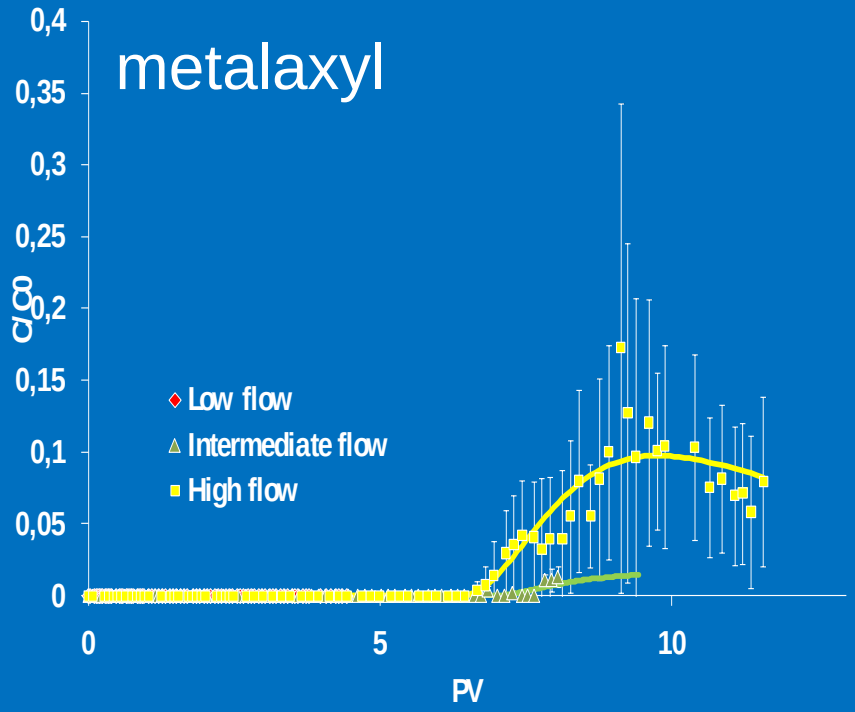






How do pesticides behave under variable flux in macrocosms?





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