Appropriateness of using lysimeter leachate concentrations as a regulatory endpoint for groundwater risk assessments

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Many lysimeter studies (based on German guideline) available in pesticide registration dossiers.
No consensus within EU on use of results of lysimeter studies in groundwater risk assessment at Member State level.
German approach: use maximum of annual leachate concentrations directly as endpoint (usually two- or three-year study).

Question: is the German approach defensible ?

Aim of this research

Testing of following assumptions in German approach:

1. lysimeter bottom boundary condition gives same leaching concentration as field bottom boundary condition
2. lysimeter study lasts long enough to measure the maximum in time
3. the pesticide-soil combination used in lysimeter is a realistic worst-case for leaching.

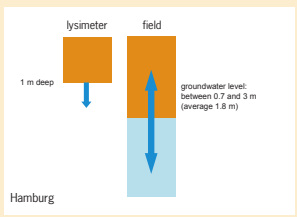
General procedure for testing

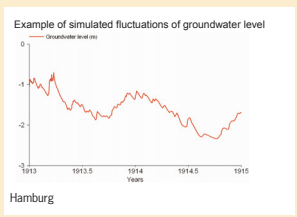
Simulations with chromatographic leaching model FOCUS PEARL v2.2.2 using
- Hamburg soil profile and Hamburg weather
- application of 1 kg/ha before emergence of summer wheat
- hypothetical pesticides including long-term sorption kinetics

Vulnerability criteria in German guideline based on chromatographic flow:
- lysimeter soil low in organic matter
- ensure annual rainfall of 800 mm via irrigation

Hypothesis 1 **Effect of lysimeter bottom boundary condition?**

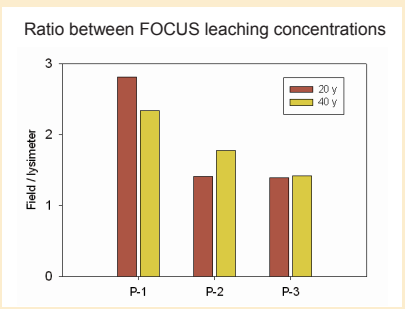
Procedure for testing
- FOCUS groundwater simulations for 20 and 40 y for three hypothetical pesticides
- comparison between (i) 1-m deep lysimeter soil and (ii) 4.5-m deep soil profile with fluctuating groundwater level





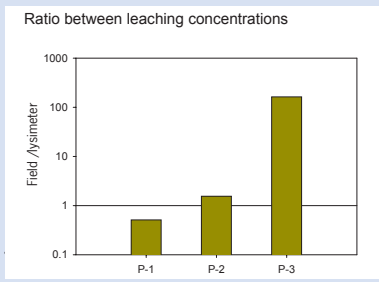
Result
Lysimeter leaching concentrations 1.4 to 2.8 times lower than field leaching concentrations: lysimeter not conservative.
Possible cause: residence time of water in lysimeter longer than in top metre of field.
Conclusion:
hypothesis rejected.

	half-life (d)	K_{OM} (L/kg)
P-1	10	0
P-2	20	35
P-3	30	90



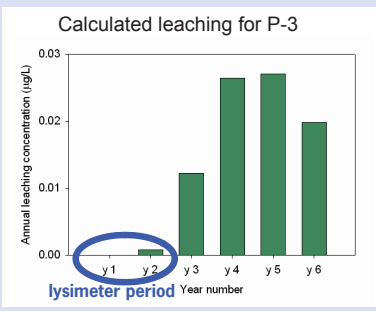
Hypothesis 2 **Does lysimeter study last long enough?**

Procedure for testing
Calculations for 1-m deep lysimeter soil and three hypothetical pesticides
Compare
(i) maximum annual leaching concentration for 2-y period with annual rainfall of 800 and 826 mm
(ii) FOCUS leaching concentration for 40-y period with application every two years.



Result
- For pesticides with K_{OM} close to zero, two years is long enough
- For moderately sorbing pesticides, two years is not long enough leading to strong underestimation of leaching concentrations

Conclusion:
answer is no for most of the pesticides



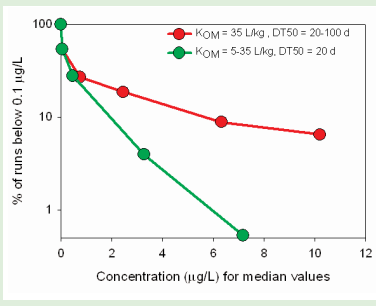
Hypothesis 3 **Is pesticide-soil combination in lysimeter a realistic worst case?**

Procedure for testing
Monte-Carlo simulations of maximum annual leaching concentration for
- 1-m deep lysimeter soil
- 2-y period with annual rainfall of 800 and 826 mm
- range of hypothetical pesticides
- stochastic K_{OM} (CV 25%), Freundlich exponent (uniform in range 0.8-1), half-life (CV 25%) and dispersion length (lognormal with median of 5 cm).

Background: these lysimeter properties are usually unknown.

Question: which percentage of runs gives concentrations below 0.1 µg/L due to this variability in pesticide-soil properties, thus producing a favourable result by coincidence?

Result
At a median leaching concentration of 1 µg/L the probability of producing a favourable lysimeter result by coincidence is >20%. Such a probability is unlikely to be acceptable to risk managers.



Overall conclusion

All hypotheses were rejected, so the German approach does not seem defensible.

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