8656

Virtual Refined Exposure Tests With Macrophytes - Using a Generic TKTD Growth Model to Predict the Effects of Time Variable Exposure on *Myriophyllum spicatum*

Hommen U[1], Klein J[1], Solga A[2], Witt J[2], TG Preuss[2]
[1] Fraunhofer Institute for Molecular Biology and Applied Ecology IME, [2] Bayer CropScience

Email: udo.hommen@ime.fraunhofer.de

Introduction

- The use of herbicides can result in the exposure of macrophytes in edge-of-field water bodies
- Exposure models like FOCUS Step 3 predict a variety of time series of possible dynamic environmental concentrations (PEC)
- Dynamic exposure events can be addressed by refined exposure
- TKTD models in connection with such tests allow addressing large number of exposure profiles
- The example herbicide belongs to the sulfonylurea herbicides (mode of action: inhibition of biosynthesis of the amino acids)

Test vessel with *M. spicatum* shoots

The model

- is a simple TKTD model already used for the duckweed *Lemna sp.* (Schmitt et al. 2013) but used to describe the effects of dynamic exposure on the sediment rooted plant *Myriophyllum spicatum*
- calculates a scaled internal concentration from the concentration in the medium and the permeability of the cuticle determining uptake and elimination
- describes the inhibition of the growth rate by a 2-parameter log-logistic function of the scaled internal concentration
- uses 3 TKTD parameters that have to be calibrated by means of growth inhibition tests
- takes the growth characteristics directly from control data
- was calibrated and validated by means of data from a standard test with constant exposure over 14 d and 3 tests with different patterns of short-term exposure events

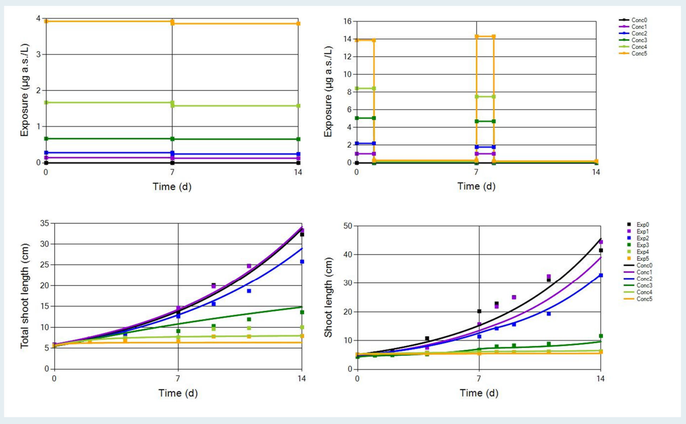
For more details and the model, see **poster 8657** by Klein et al.

Results

Calibration

- A standard test with constant exposure and a test with exposure on day 1 and 8 was used
- A good result was obtained: model efficiency = 0.96 and 0.94, NRMSE = 0.109 and 0.216

Calibration

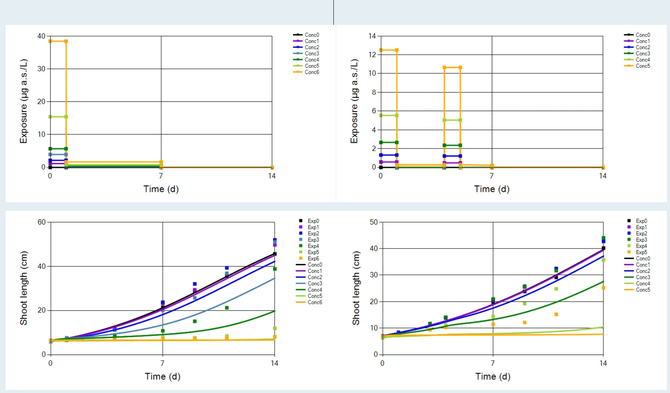


Exposure patterns (top) and observed (symbols) and predicted (lines) growth of M. spicatum using the data of test A (left) and C (right) for calibration (bottom)

Validation

- Model performance for validation is worse than for the calibration due to variability between the experimental results for similar exposure situations and the selection of the most sensitive test for calibration
- Nevertheless, model efficiency is still positive and the NRMSE is still < 0.5
- Inhibition of the growth rate in these tests is overestimated on average by 17% and 32 %

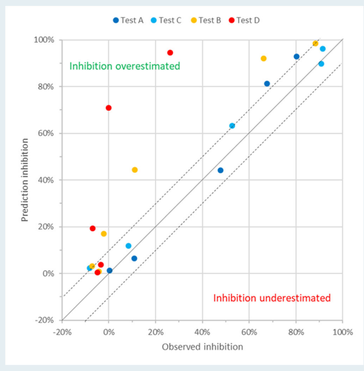
Validation



Exposure patterns (top) and observed (symbols) and predicted (lines) growth of M. spicatum using the data of test B (left) and D (right) for validation

- The model is <u>suitable</u> for predictions of the effects on *Myriophyllum spicatum* of dynamic exposure to the active substance, but it might be biased to overestimate effects
- The model was considered suitable for <u>conservative predictions</u> of the effects of dynamic exposure of the herbicide on *Myriophyllum spicatum*

Growth inhibition in calibration and validation

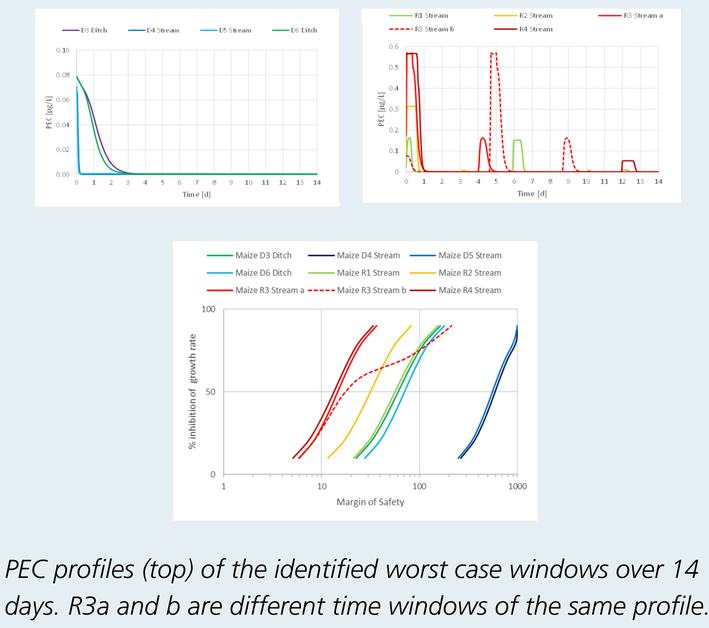


Modelled and observed inhibition of growth rate of M. spicatum. Test A and C were used for calibration of the TKTD parameters while Test B and D were used for validation . Dashed lines: deviations < 10 % inhibition

Prediction

- PECs of the worst-case 14 d time windows of FOCUS Step 3 exposure profiles were used as model inputs to simulate standard growth inhibition tests with time variable exposure
- According to EFSA's Scientific Opinion on TKTD modelling, EP50 values were calculated, i.e. multiplication factors resulting in 50 % inhibition of the growth rate over the 14 d standard test duration (i.e. the Tier 1 assessment endpoint) if applied to the FOCUS Step 3 PEC values

Prediction



PEC profiles (top) of the identified worst case windows over 14 days. R3a and b are different time windows of the same profile. Margins of safety (bottom) for effects on growth rate in the worst-case 14 d time. The EP50 are the margins of safety for 50 % inhibition

Conclusions

- A relatively simple conservative TKTD model for growth inhibition of *M. spicatum* could be calibrated and validated for the example substance
- The exposure events are only short and the TKTD model predicts margins of safety for 50 % inhibition of the growth rate over 14 days (EP50) higher than 10, the Tier 1 assessment factor, for the given exposure patterns

References
- EFSA PPR Panel (2013): Conclusion on the peer review of the pesticide risk assessment of the active substance thiencarbazone-methyl. EFSA Journal 2013;11(7):3270, 77 pp. doi:10.2903/j.efsa.2013.3270
- EFSA PPR panel (2018): Scientific Opinion on the state of the art of Toxicokinetic/Toxicodynamic (TKTD) effect models for regulatory risk assessment of pesticides for aquatic organisms. EFSA Journal 2018; 16(8):5377, 188 pp. https://doi.org/10.2903/j.efsa.2018.5377
- Schmitt W, Bruns E, Dollinger M, Sowig P (2013): Mechanistic TKTD-model simulating the effect of growth inhibitors on *Lemna* populations. Ecol Model 255:1– 10.
- Klein J, Hommen U, Preuss TG, Witt J (2022). Why a *Lemna* TKTD Model Can Also Be Applied to Sediment Rooted Macrophytes. Poster 8657. SETAC Europe Annual Meeting 2022. Copenhagen.

This work was financed by Bayer AG, Germany.