Macrophytes in ecotoxicology – the global Aquatic Macrophyte Ecotoxicology advisory Group – AMEG

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Background of AMEG

2008: Workshop on Aquatic Macrophyte Risk Assessment for Pesticides (AMRAP), organized under the auspices of the Society of Environmental Toxicology and Chemistry (SETAC)

Main outcomes:

- Risk assessment of herbicides under the EU Directive 91/414/EEC with only one macrophyte species (*Lemna* sp.) may not be sufficiently protective of all macrophyte species across all chemicals
- Development of decision-making criteria for the use of additional macrophyte tests in risk assessment
- A global SETAC Advisory Group on Aquatic Macrophyte Ecotoxicology (AMEG) was formed in 2009 as a forum for scientists participating in macrophyte research

Fig. 1: The sediment test system with Myriphyllum spicatum, Origin: Ibacon

Myriophyllum working group

- Development of a new test protocol for the sediment-rooted, dicotyledonous species *Myriophyllum aquaticum* and *M. spicatum.*
- Ring-rested in 2011 and submitted to OECD for consideration as a test guideline (Fig. 1 and Tab. 1)

Conclusions of *Myriophyllum* ring test

- Proportion of tests considered valid was higher using *M. spicatum* then using *M. aquaticum*
- Coefficient of intra-lab variation was considered sufficiently low (max. 24 %) to allow reproducible estimation of EC_{50} values
- Recommended endpoints are likely to include yield and growth rate, estimated from fresh weight and shoot length

Tab 1: Myriophyllum test protocol

	Myriophyllum protocol
Test species	*M. spicatum* or *M. aquaticum*
Medium	Smart-Barko medium (without N & P)
Sediment	OECD 219 sediment (plus N & P)
Temperature	22 +/- 2°C
pH, O2	Measured at start, end and twice in between
Test duration	14 d (*M. spicatum*) or 7 d (*M. aquaticum*)
Plants per vessel	3
Control replicates	6
Treatment levels	5
Treatment replicates	3
Plants per test	63
Validity criteria	Doubling of mean main shoot length of controls
Endpoints	Value at end of test, yield (increase over test), growth rate (assuming exp. growth of shoots)
Statistics	Effect concentrations (EC50/20) via probit analysis for metric data, no effect concentrations (NOECs) via Williams-test

SSD working group

- Applying the Species Sensitivity Distributions (SSD) concept for exploring the sensitivity of standard test species relative to other macrophyte species and algae to reduce uncertainty over variability of intrinsic toxicity between different species
- Evaluation of 2000 macrophyte endpoints for 14 compounds and 55 species from published literature and confidential herbicide dossiers (Giddings et al. 2011)

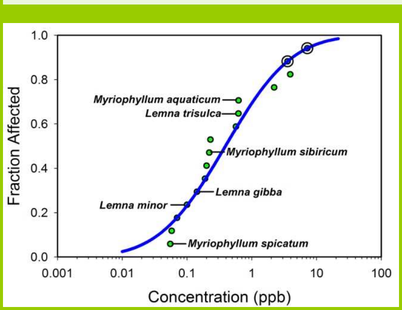

Fig. 2: Species Sensitivity Distributions (SSD) for herbicide 'X' with a certain mode of action

Conclusions of the SSDs

- No single species consistently represents the most sensitive macrophyte species (Fig. 2)
- The combination of the 4 algae and *Lemna gibba* from standard tests almost always includes an EC_{50} near or below the EC_{50} of the most sensitive macrophyte
- For exceptional chemicals to which algae and *Lemna gibba* are less sensitive, *M. spicatum* is among the most sensitive species.

References

Arts, G. et al. 2010. AMEG: the new SETAC advisory group on aquatic macrophyte ecotoxicology. Environ. Sci. Pollut. Res. 17 (4), 820-823.

Davies et al. 2003. Herbicide risk assessment for non-target aquatic plants: Sulfosulfuron - A case study. Pest Management Sci., 59 (2): 231-237.

Giddings 2011. The Relative Sensitivity of Macrophyte and Algal Species to Herbicides and Fungicides: An Analysis Using Species Sensitivity Distributions. CSI Report No. 11702. Available at: www.complianceservices.com/Page.aspx?nid=265<http://www.complianceservices.com/Page.aspx?nid=265.

Maltby et al. 2010. Aquatic Macrophyte Risk Assessment for Pesticides. CRC Press, Boca Raton, pp. 135.

Objectives of AMEG

- Provide a scientific basis for aquatic macrophyte testing and chemical risk assessment
- Development of guidance on aquatic macrophyte testing and aquatic macrophyte risk assessment
- Coordination of existing working groups (*Myriopyllum* working group, Species Sensitivity Distributions working group)
- Build and extend a global network of macrophyte experts from academia, business and government
- Provide an overview of ongoing activities and new initiatives in the subject area via the SETAC website and newsletters

Upcoming challenges

Higher-tier macrophyte studies in micro/mesocosms:

- Refinement of existing guidance
- Questions: Which study design (potted or free living populations, Fig. 3 and 4) and how to interpret the data? Which species deliver reasonable results and which ecotoxicological and regulatory endpoints should be considered?

***Glyceria maxima* guidance document**

- Refinement of existing guideline (Davies et al. 2003) since additional standardized test for grass herbicides is proposed in the new EU pesticide directive 1107/2009/EC
- Organization and evaluation of a ring test, test guideline submission to OECD

Fig. 3 and 4: Mesocosm with macrophytes and Gyceria maxima in pots (Origin: UBA)

Modelling macrophytes

- Toxicokinetic/toxicodynamic models for analyzing exposure and effects
- Macrophyte population models for modeling growth and predicting effects of realistic environmental conditions
- Spatially explicit community models for e.g. analyzing where aquatic plants are at risk and how recovery is affected by competition
- Questions: which models could be useful in refined risk assessments?

Macrophyte risk assessment and climate change

- Climate change may affect contaminant exposure and toxic effects
- Concepts needed for translating patterns into robust aquatic macrophyte risk assessment