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Is the sensitivity of *Lemna* and *Lemna* endpoints to metsulfuron-methyl representative of other macrophyte species and endpoints?

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1. Objective

The aim of this research was to answer the question:
Is the sensitivity of *Lemna* and *Lemna* endpoints to metsulfuron-methyl representative of other macrophyte species and endpoints?

Figure 1. Overview of experimental set-up.

2. Materials and Methods

- Laboratory toxicity tests with aquatic macrophytes:
  - Chronic non-axenic 21-days tests;
  - Barko and Smart[2] medium;
  - Natural fine clay sediment;
  - Seventeen submerged macrophytes (monocotyledones and dicotyledones);
  - 3 apical, unbranched macrophyte shoots (10 cm) or 10 fronds of *Lemnaceae*;
  - Range of species (n=17): Figures 2-6.
- Controlled conditions:
  - 17°C; 14/10 light/dark regime; 400 W Philips HPI-T lamps; illumination 160 ± 65 µmol.m^{-2}.s^{-1} at water surface level.
- High potency herbicide biologically active at very low concentrations (ng/L)[7].
- Test concentrations of the herbicide metsulfuron-methyl: 1 – 3300 ng/L.
- Compound is more toxic to aquatic macrophytes than to algae[9].
- Macrophyte toxicity data were generated in a climate room (method described above) (Dorsman, 2007[5]; Jonas, 2008[8]) and collected from literature (Fairchild, 1998[6]; Roshon et al., 1999[9]; Brock et al., 2000[3]; Cedergreen et al., 2004[4]).
- Log-normal distributions were calculated and plotted[1,10] to generate species sensitivity distributions (SSDs) and endpoint distributions. Model fit was evaluated using the Anderson-Darling goodness-of-fit test.

Figure 2. Myriophyllum spicatum.

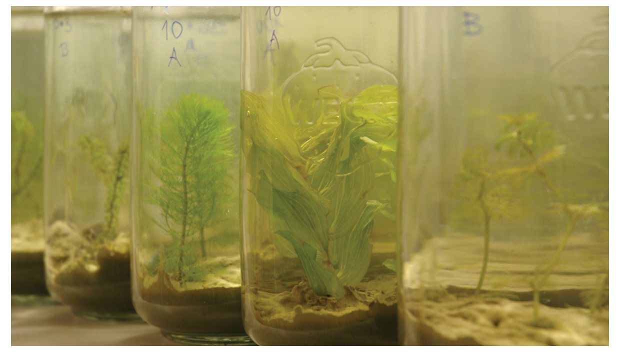

Figure 3. Myriophyllum aquaticum and Potamogeton perfoliatus.

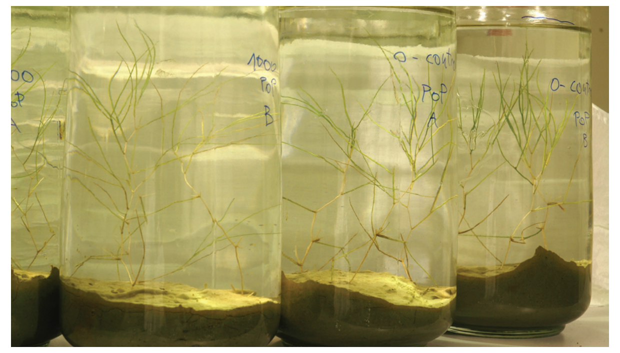

Figure 4. Potamogeton pectinatus.

Figure 5. Elodea canadensis.

Figure 6. Lemna species.

3. Evaluation of species sensitivity distributions and endpoint distributions from single macrophyte species

3.1 Sensitivity of macrophytes

Myriophyllum spicatum is the most sensitive species for a range of endpoints (Fig. 7). The sensitivity of the species *Lemna gibba/minor* is very close to the sensitivity of *Elodea nuttallii* for a range of endpoints (Fig. 7). *Myriophyllum spicatum* is in the lower end of the SSDs (Fig. 8). *Lemna minor* and *Lemna gibba* are near the middle of the SSDs, *Lemna trisulca* and *Myriophyllum aquaticum* are in the upper end (Fig. 8).

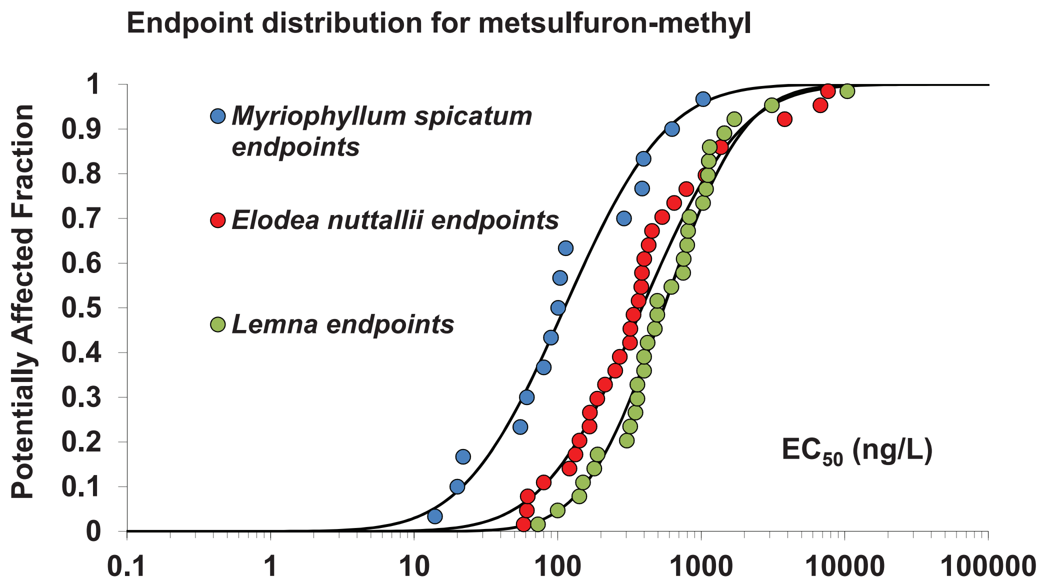

Figure 7. Endpoint distributions from single macrophyte species for metsulfuron-methyl.

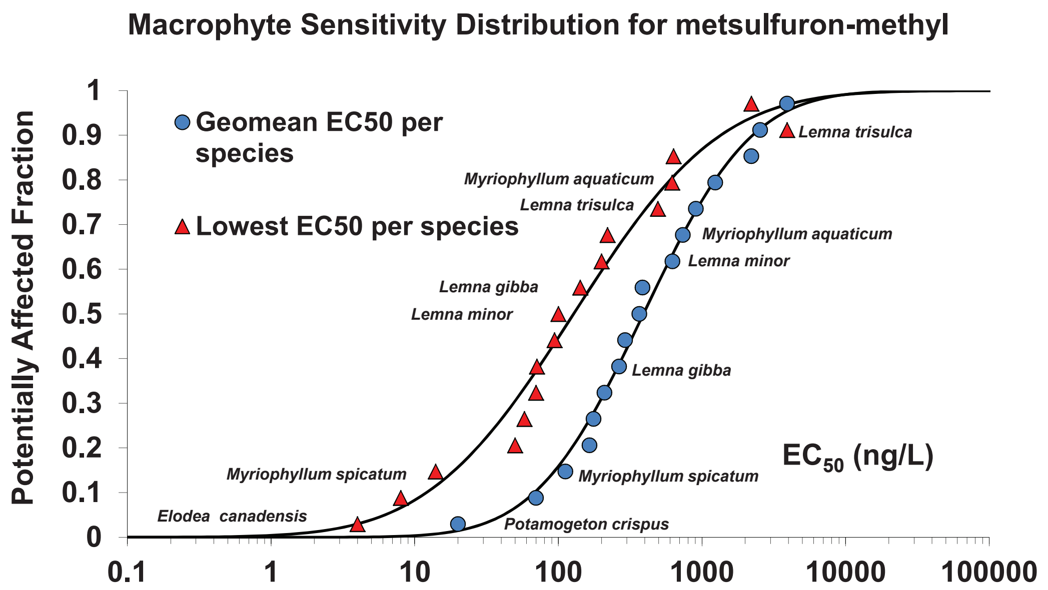

Figure 8. Macrophyte Species Sensitivity Distributions for metsulfuron-methyl based on the geomean approach and on the lowest endpoint approach.

Evaluation of the lowest reported EC_{50} for each species is a more conservative approach compared to the evaluation of the geomean of the reported EC_{50} values for each species.

The 5 % hazard concentrations (HC_5) of the EC_{50}-based SSDs for metsulfuron-methyl are in the same range as or are lower than published values (Table 1; Cedergreen *et al.*, 2004). The HC_5 values are dependent on the toxicity endpoints and measurement endpoints evaluated in the specific SSDs.

Table 1. Hazard concentrations (ng/L) for macrophyte sensitivity distributions and for endpoint distributions.

Species	LL HC5	HC5	UL HC5	Goodness of Fit	Type of Distribution	Toxicity values included	Figure
Lemna	60.2	103.2	154.3	Accepted	Endpoint distribution	all EC50 values	Fig. 7
Myriophyllum spicatum	4.2	13.0	26.8	Accepted	Endpoint distribution	all EC50 values	Fig. 7
Elodea nuttallii	25.2	49.1	80.7	Accepted	Endpoint distribution	all EC50 values	Fig. 7
17 macrophyte species	13.1	39.7	82.4	Accepted	Species distribution	Geomean of EC50 values per species	Fig. 8
17 macrophyte species	1.3	5.8	15.6	Accepted	Species distribution	Lowest EC50 per species	Fig. 8
9 macrophyte species	10.9	56.1	137.1	Accepted	Species distribution	for endpoint Specific Leaf Area	Fig. 9
8 macrophyte species	0.2	4.5	22.9	Accepted	Species distribution	for endpoint average length of new shoots	Fig. 9

3.2 Sensitivity of endpoints

The average length of the new shoots is a more sensitive endpoint than the specific leaf area (Table 1 and Fig. 9).

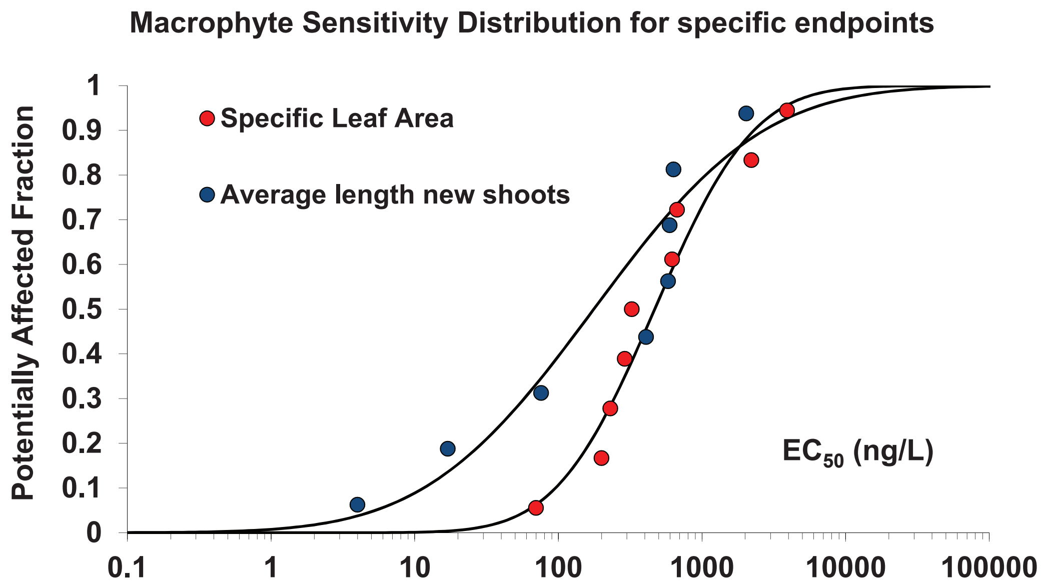

Figure 9. Macrophyte Species Sensitivity Distributions for metsulfuron-methyl based on specific endpoints.

4. Conclusions

Myriophyllum spicatum is among the most sensitive species for metsulfuron-methyl. The formation of new tissues is a very sensitive endpoint for submerged, rooted, aquatic macrophytes and reflects the mode of action of the herbicide. Differences between *Lemna gibba/minor* and species more sensitive to metsulfuron-methyl are exceeding a factor of 10.

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