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BERLIN
6th SETAC World Congress 2012
SETAC Europe 22nd Annual Meeting | 20-24 May

Highest tier? EPAT analysis in aquatic risk assessment of plant protection products

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Abstract

For standard risk assessment conducted during the EU review of plant protection products (PPP), the concentration of active substances in water bodies adjacent to a single field is calculated using the surface water model FOCUS SWASH. For higher tier assessment, micro- and mesocosm studies or probabilistic approaches (*e.g.* SSD - Species sensitivity distribution) can be used. On the exposure side more realistic PEC calculations by means of mitigation measures such as buffer zones or drift reducing nozzles or the use of PEC_{twa} values for chronic endpoints may considerably reduce the risk. However, for the FOCUS D scenarios - in particular for the D2 which has to be considered in winter cereals and winter oilseed rape - only limited mitigation measures are available as drainage is the main entry path. In such cases, an analysis of the exposure profile in water and sediment may give valuable information for a successful estimation of risks to aquatic organisms.

For that reason the exposure pattern analysis tool EPAT was used to characterise the exposure pattern of various active substances in surface water. The main focus was set on specific compounds that enter the aquatic environment via drainage. By this, potential uses of EPAT as a refinement tool for acute and chronic risk assessment are presented and critically discussed.

Material & Methods

Calculations performed to estimate predicted environmental concentrations in surface water (PECsw) for 8 active substances (see Tab. 1), resulting from realistic applications on winter cereals or winter oilseed rape, were simulated using the FOCUS surface water models FOCUS SWASH (Step 3) and SWAN (Step 4) and DT_{50} water/sediment values established in the respective EU review. In addition, EPAT was used to characterise the exposure pattern of these substances in surface water: Periods during which pesticide concentrations exceed the threshold value ($\text{Endpoint/Trigger}_{\text{Regulation(EU)546/2011}}$) were analysed e.g. on maximum concentration, the number of extrema, the interval since the previous event as well as global maximum concentrations, median values and percentiles.

Tab. 1

Substance	Most sensitive species	Critical Endpoint	Threshold value[1]	Source
Bromuconazole	*D. magna*	21 d NOEC = 20 µg/L	2 µg/L	EFSA Journal 2010; 8(8):1704
Carbendazim	*D. magna*	21d NOEC = 1.5 µg/L	0.15 µg/L	EFSA Journal 2010; 8(5):1598
Fenpropidin	*S. subspicatus*	72 hr E_bC_{50} = 0.8 µg/L	0.08 µg/L	EFSA Scientific Report (2007) 124. 1-84
Dimethachlor	*L. gibba*	7 d E_bC_{50} = 35 µg/L	3.5 µg/L	EFSA Scientific Report (2008) 169. 1-111
Epoxiconazole	*L. gibba*	7 d E_bC_{50} = 4.3 µg/L	0.43 µg/L	EFSA Scientific Report (2008) 138. 1-80
Isoxaben	*L. gibba*	7 d E_bC_{50} = 13 µg/L	1.3 µg/L	EFSA Journal 2010;8(9):1714
Metazachlor	*L. gibba*	7 d E_bC_{50} = 2.3 µg/L	0.23 µg/L	EFSA Scientific Report (2008) 145. 1-132
Paclobutrazol	*L. gibba*	7d EC_{50} = 8.2 µg/L	0.82 µg/L	EFSA Journal 2010;8(11):1876

[1] Threshold value = Critcal endpoint/Regulation (EU) 546/2011 chronic trigger value 10

Peak concentrations exceeding the treshold value were analysed further regarding the monthly maximum concentrations.

Results & Discussion

For the eight investigated substances no safe uses in cereals or oilseed rape could be identified following a standard risk assessment using FOCUS Step 4 PEC values with the usual mitigation measures (maximum buffer zone 20 m).

However, by using EPAT in combination with an analysis of the monthly maximum concentrations for 2 substances, namely Dimethachlor and Metazachlor, it could be shown that it is very unlikely that the predicted high peak concentration of the respective substance will lead to significant adverse effects on the most sensitive species. A detailed example is shown below:

Example Dimethachlor: Relevant endpoint: 7d E_bC_{50} = 35 µg/L (*Lemna gibba*) (EFSA Scientific Report (2008) 169. 1-111)
TER calculations for FOCUS Step 4 failed for scenario D2 (ditch + stream) D4 (ditch & stream), R1 and R3 stream considering 20 m buffer zone

Tab. 2: EPAT Results

	Event no.	Start date & time	t [day]	Interval [days]	No. extrema	Max conc. (µg/L)	Average peak conc. (µg/L)	Duration (d)
D2 ditch	1	01.01.1986 04:00	0.167	-	5	**6.958**	4.49	10.8
	2	19.10.1986 06:00	291	280	20	**146.253**	25.4	51.583
D2 stream	1	01.01.1986 02:00	0.083	-	1	**4.325**	3.93	0.5
	2	19.10.1986 06:00	291	290	35	**91.576**	15.36	42.5
D4 pond	1	11.12.1985 13:00	344	-	1	**4.714**	4.14	60.708
D4 stream	1	05.12.1985 09:00	338	-	5	**8.001**	5.76	8.208
R1 stream	1	25.10.1978 02:00	24	-	1	**12.108**	10.52	0.375
R3 stream	1	04.11.1980 01:00	34	-	2	**6.431**	6.34	0.625

Peak concentrations exceeding the threshold value (see Tab. 2) were analysed further regarding the monthly maximum concentrations (see Tab. 3): The peak dimethachlor concentrations are restricted to October to February scenarios. The vegetation period of aquatic plants (e.g. *L. gibba)* is predominantly during the spring and summer months. During winter, aquatic plants in general are reducing photosynthesis and the uptake of nutrients. It is therefore very unlikely that the predicted high peak concentration of dimethachlor between October and February will lead to significant adverse effects on aquatic plants.

Tab. 3: Monthly Maximum Concentrations

	D2 ditch		D2 stream		D4 pond		R4 stream		R1 stream		R3 stream	
Year-Month	Conc. [µg/L]	Safe use?	Conc. [µg/L]	Safe use?	Conc. [µg/L]	Safe use?	Conc. [µg/L]	Safe use?	Conc. [µg/L]	Safe use?	Conc. [µg/L]	Safe use?
1986-01	**6.958**	not safe	**4.325**	not safe	0.021	safe	0.126	safe	inf	-	inf	-
1986-02	1.581	safe	1.013	safe	0.429	safe	1.587	safe	inf	-	inf	-
1986-03	1.213	safe	0.806	safe	0.397	safe	0.112	safe	inf	-	inf	-
1986-04	0.496	safe	0.302	safe	0.326	safe	0.134	safe	inf	-	inf	-
1986-05	0.251	safe	0.161	safe	0.281	safe	0.015	safe	inf	-	inf	-
1986-06	0.123	safe	0.106	safe	0.223	safe	0.002	safe	inf	-	inf	-
1986-07	0.060	safe	0.040	safe	0.177	safe	0.000	safe	inf	-	inf	-
1986-08	0.080	safe	0.087	safe	0.136	safe	0.000	safe	inf	-	inf	-
1986-09	0.076	safe	0.087	safe	0.105	safe	0.000	safe	inf	-	inf	-
1986-10	**146.25**	not safe	**91.576**	not safe	0.206	safe	0.828	safe	**12.108**	not safe	0.885	safe
1986-11	**51.054**	not safe	**31.696**	not safe	0.196	safe	0.000	safe	1.906	safe	**6.431**	not safe
1986-12	**5.904**	not safe	**3.436**	not safe	**4.714**	not safe	**8.001**	not safe	0.186	safe	0.000	safe
1987-01	1.393	safe	0.876	safe	**4.577**	not safe	0.943	safe	0.000	safe	0.000	safe
1987-02	0.660	safe	0.408	safe	**3.733**	not safe	0.504	safe	0.000	safe	0.000	safe
1987-03	0.372	safe	0.238	safe	3.097	safe	0.177	safe	0.000	safe	0.000	safe
1987-04	0.246	safe	0.159	safe	2.564	safe	0.157	safe	0.000	safe	0.000	safe
1987-05	0.146	safe	0.117	safe	2.133	safe	0.126	safe	0.000	safe	0.000	safe

Conclusion

EPAT in combination with an analysis of monthly maximum concentrations makes it possible to refine the aquatic risk assessment of pesticides which fail the standard risk assessment. It could be shown that it is very unlikely that the predicted high peak concentration of the respective substance will lead to significant adverse effects on the most sensitive species.

Acknowledgements

The authors would like to thank Gisela Wiedemann and Oliver Körner for their support.