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This investigation has been performed by order and for the account of Directorate-General for Environmental Protection, Directorate for Soil, Water and Rural Area (BWL), within the framework of the project ‘Standard setting for other relevant substances within the WFD’.

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Rapport in het kort

Environmental risk limits for monolinuron

Dit rapport geeft milieurisicogrenzen voor het herbicide monolinuron in water. Milieurisicogrenzen zijn de technisch-wetenschappelijke advieswaarden voor de uiteindelijke milieukwaliteitsnormen in Nederland. De milieurisicogrenzen zijn afgeleid volgens de methodiek die is voorgeschreven in de Europese Kaderrichtlijn Water. Hierbij is gebruikgemaakt van de beoordeling in het kader van de Europese toelating van gewasbeschermingsmiddelen (Richtlijn 91/414/EEG), aangevuld met gegevens uit de openbare literatuur.

Contents

1 Introduction

1.1 Background and scope of the report

In this report, environmental risk limits (ERLs) for surface water are derived for the herbicide monolinuron. The derivation is performed within the framework of the project 'Standard setting for other relevant substances within the WFD', which is closely related to the project 'International and national environmental quality standards for substances in the Netherlands' (INS). Monolinuron is part of a series of 25 pesticides that appeared to have a high environmental impact in the evaluation of the policy document on sustainable crop protection ('Tussenevaluatie van de nota Duurzame Gewasbescherming'; MNP, 2006) or were selected by the Water Boards ('Unie van Waterschappen'; project 'Schone Bronnen'; http://www.schonebronnen.nl/).

The following ERLs are considered:

- Maximum Permissible Concentration (MPC) – the concentration protecting aquatic ecosystems and humans from effects due to long-term exposure
- Maximum Acceptable Concentration (MAC_{eco}) – the concentration protecting aquatic ecosystems from effects due to short-term exposure or concentration peaks.
- Serious Risk Concentration (SRC_{eco}) – the concentration at which possibly serious ecotoxicological effects are to be expected.

More specific, the following ERLs can be derived depending on the availability of data and characteristics of the compound:

$MPC_{eco, water}$	MPC for freshwater based on ecotoxicological data (direct exposure)
$MPC_{sp, water}$	MPC for freshwater based on secondary poisoning
$MPC_{hh food, water}$	MPC for fresh and marine water based on human consumption of fishery products
$MPC_{dw, water}$	MPC for surface waters intended for the abstraction of drinking water
$MAC_{eco, water}$	MAC for freshwater based on ecotoxicological data (direct exposure)
$SRC_{eco, water}$	SRC for freshwater based on ecotoxicological data (direct exposure)
$MPC_{eco, marine}$	MPC for marine water based on ecotoxicological data (direct exposure)
$MPC_{sp, marine}$	MPC for marine water based on secondary poisoning
$MAC_{eco, marine}$	MAC for marine water based on ecotoxicological data (direct exposure)

1.2 Status of the results

The results presented in this report have been discussed by the members of the scientific advisory group for the INS-project (WK-INS). It should be noted that the Environmental Risk Limits (ERLs) in this report are scientifically derived values, based on (eco)toxicological, fate and physico-chemical data. They serve as advisory values for the Dutch Steering Committee for Substances, which is appointed to set the Environmental Quality Standards (EQSs). ERLs should thus be considered as proposed values that do not have any official status.

2 Methods

The methodology for the derivation of ERLs is described in detail by Van Vlaardingen and Verbruggen (2007), further referred to as the ‘INS-Guidance’. This guidance is in accordance with the guidance of the Fraunhofer Institute (FHI; Lepper, 2005).

The process of ERL-derivation contains the following steps: data collection, data evaluation and selection, and derivation of the ERLs on the basis of the selected data.

2.1 Data collection

In accordance with the WFD, data of existing evaluations were used as a starting point. For monolinuron, the evaluation report prepared within the framework of EU Directive 91/414/EC (Draft Assessment Report, DAR) was consulted (EC, 1996; 1997; further referred to as DAR). An on-line literature search was performed on TOXLINE (literature from 1985 to 2001) and Current contents (literature from 1997 to 2007). In addition to this, all potentially relevant references in the RIVM e-tox base and EPA’s ECOTOX database were checked.

2.2 Data evaluation and selection

For substance identification, physico-chemical properties and environmental behaviour, information from the List of Endpoints of the DAR was used. When needed, additional information was included according to the methods as described in Section 2.1 of the INS-Guidance. Information on human toxicological threshold limits and classification was also primarily taken from the DAR.

Ecotoxicity studies (including bird and mammal studies) were screened for relevant endpoints (i.e. those endpoints that have consequences at the population level of the test species). All ecotoxicity and bioaccumulation tests were then thoroughly evaluated with respect to the validity (scientific reliability) of the study. A detailed description of the evaluation procedure is given in the INS-Guidance (see Section 2.2.2 and 2.3.2). In short, the following reliability indices were assigned:

- Ri 1: Reliable without restriction
  ’Studies or data … generated according to generally valid and/or internationally accepted testing guidelines (preferably performed according to GLP) or in which the test parameters documented are based on a specific (national) testing guideline … or in which all parameters described are closely related/comparable to a guideline method.’
- Ri 2: Reliable with restrictions
  ’Studies or data … (mostly not performed according to GLP), in which the test parameters documented do not totally comply with the specific testing guideline, but are sufficient to accept the data or in which investigations are described which cannot be subsumed under a testing guideline, but which are nevertheless well documented and scientifically acceptable.’
- Ri 3: Not reliable
  ’Studies or data … in which there are interferences between the measuring system and the test substance or in which organisms/test systems were used which are not relevant in relation to the exposure (e.g., unphysiologic pathways of application) or which were carried out or generated according to a method which is not acceptable, the documentation of which is not sufficient for an assessment and which is not convincing for an expert judgment.’

- Ri 4: Not assignable
  'Studies or data … which do not give sufficient experimental details and which are only listed in short abstracts or secondary literature (books, reviews, etc.).'

All available studies were summarised in data-tables, that are included as Appendices to this report. These tables contain information on species characteristics, test conditions and endpoints. Explanatory notes are included with respect to the assignment of the reliability indices.

With respect to the DAR, it was chosen not to re-evaluate the underlying studies. In principle, the endpoints that were accepted in the DAR were also accepted for ERL-derivation with Ri 2, except in cases where the reported information was too poor to decide on the reliability or when there was reasonable doubt on the validity of the tests. This applies especially to DARs prepared in the early 1990s, which do not always meet the current standards of evaluation and reporting.

In some cases, the characteristics of a compound (i.e. fast hydrolysis, strong sorption, low water solubility) put special demands on the way toxicity tests are performed. This implies that in some cases endpoints were not considered reliable, although the test was performed and documented according to accepted guidelines. If specific choices were made for assigning reliability indices, these are outlined in Section 3.3 of this report.

Endpoints with Ri 1 or 2 are accepted as valid, but this does not automatically mean that the endpoint is selected for the derivation of ERLs. The validity scores are assigned on the basis of scientific reliability, but valid endpoints may not be relevant for the purpose of ERL-derivation (e.g. due to inappropriate exposure times or test conditions that are not relevant for the Dutch situation).

After data collection and validation, toxicity data were combined into an aggregated data table with one effect value per species according to Section 2.2.6 of the INS-Guidance. When for a species several effect data were available, the geometric mean of multiple values for the same endpoint was calculated where possible. Subsequently, when several endpoints were available for one species, the lowest of these endpoints (per species) is reported in the aggregated data table.

2.3 Derivation of ERLs

For a detailed description of the procedure for derivation of the ERLs, reference is made to the INS-Guidance. With respect to the selection of the final MPC_{water} some additional comments should be made:

2.3.1 Drinking water

The INS-Guidance includes the MPC for surface waters intended for the abstraction of drinking water ($MPC_{dw, water}$) as one of the MPCs from which the lowest value should be selected as the general MPC_{water} (see INS-Guidance, Section 3.1.6 and 3.1.7). According to the proposal for the daughter directive Priority Substances, however, the derivation of the AA-EQS (= MPC) should be based on direct exposure, secondary poisoning, and human exposure due to the consumption of fish. Drinking water was not included in the proposal and is thus not guiding for the general MPC value. The exact way of implementation of the $MPC_{dw, water}$ in the Netherlands is at present under discussion within the framework of the "AMvB Kwaliteitseisen en Monitoring Water". No policy decision has been taken yet, and the $MPC_{dw, water}$ is therefore presented as a separate value in this report. The MPC_{water} is thus derived considering the individual MPCs based on direct exposure ($MPC_{eco, water}$), secondary poisoning ($MPC_{sp, water}$) or human consumption of fishery products ($MPC_{hh food, water}$); the need for derivation of the latter two is dependent on the characteristics of the compound.

Related to this is the inclusion of water treatment for the derivation of the $MPC_{dw, water}$. According to the INS-Guidance (see Section 3.1.7), a substance specific removal efficiency related to simple water treatment should be derived in case the $MPC_{dw, water}$ is lower than the other MPCs. For pesticides, there is no agreement as yet on how the removal fraction should be calculated, and water treatment is therefore not taken into account. In case no A1 value is set in Directive 75/440/EEC, the $MPC_{dw, water}$ is set to the general Drinking Water Standard of 0.1 µg/L for organic pesticides as specified in Directive 98/83/EC.

3 Derivation of environmental risk limits for monolinuron

3.1 Substance identification, physico-chemical properties, fate and human toxicology

3.1.1 Identity

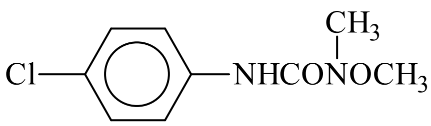

Figure 1. Structural formula of monolinuron.

Table 1. Identification of monolinuron.

Parameter	Name or number	Source
Common/trivial/other name	Monolinuron	
Chemical name	3-(4-chlorophenyl)-1-methoxy-1-methylurea	Tomlin, 2002
CAS number	1746-81-2	Tomlin, 2002
EC number	217-129-5	Tomlin, 2002
SMILES code	O=C(N(OC)C)Nc(ccc(c1)Cl)c1	U.S. EPA, 2007
Use class	Herbicide	
Mode of action	Photosystem II electron transport inhibitor	Tomlin, 2002
Authorised in NL	No	
Annex 1 listing	No	

3.1.2 Physico-chemical properties

Table 2. Physico-chemical properties of monolinuron.

Parameter	Unit	Value	Remark	Reference
Molecular weight	[g/mol]	214.6		EC, 1997
Water solubility	[g/L]	0.74	pH 7; 25 ºC	EC, 1997
pK_a	[-]	-	No dissociation	EC, 1997
log K_{OW}	[-]	2.2		EC, 1997
log K_{OC}	[-]	1.80		EC, 1997
Vapour pressure	[Pa]	1.3×10^{-3}	20 ºC	EC, 1997
Melting point	[°C]	80-83		EC, 1997
Boiling point	[°C]	-		EC, 1997
Henry's law constant	[Pa.m^3/mol]	5.65×10^{-4}		EC, 1997

3.1.3 Behaviour in the environment

Table 3. Selected environmental properties of monolinuron.

Parameter	Unit	Value	Remark	Reference
Hydrolysis half-life	DT50 [d]	Stable		EC, 1997
Photolysis half-life	DT50 [d]	Stable		EC, 1997
Readily biodegradable		No data		EC, 1997
Degradation in water/sediment systems	DT50 (system) [d]	22		EC, 1997
Relevant metabolites	N-(chlorophenyl)-N'-methylurea		Max. 40% after 30d (sediment and water)	EC, 1997

3.1.4 Bioconcentration and biomagnification

An overview of the bioaccumulation data for monolinuron is given in Table 4.

Table 4. Overview of bioaccumulation data for monolinuron.

Parameter	Unit	Value	Remark	Reference
BCF (fish)	[L./kg]	14.8	Calculated from log BCF_{fish} = 0.85 x log K_{ow} – 0.70	Veith et al.,1979
BMF	[kg/kg]	1	Default value for log K_{OW} = 2.2	Van Vlaardingen en Verbruggen, 2007

3.1.5 Human toxicological threshold limits and carcinogenicity

Monolinuron has the following R phrases: R 22, 48/22 (ESIS, http://ecb.jrc.it/esis/; European Chemicals Bureau, 2008). The ADI is 0.003 mg/kg bw. The AOEL is 0.0065 mg/kg bw/day. Monolinuron is not carcinogenic or mutagenic and has no effects on reproduction. The human health protection assessment is not triggered (EC, 1997).

3.2 Trigger values

This section reports on the trigger values for ERLwater derivation (as demanded in WFD framework).

Table 5. Monolinuron: collected properties for comparison to MPC triggers.

Parameter	Value	Unit	Method/Source	Derived at section
Log $K_{p,susp-water}$	0.80	[-]	$K_{OC} \times f_{OC,susp}$ [1]	K_{OC}: 3.1.2
BCF	14.8	[L/kg]		3.1.4
BMF	1	[kg/kg]		3.1.4
Log K_{OW}	2.2	[-]		3.1.2
R phrases	R 22, 48/22, R50/53	[-]		3.1.5
A1 value	1.0	[μg/L]	Total pesticides	
DW Standard	0.1	[μg/L]	General value for organic pesticides	

1 $f_{OC,susp}$ = 0.1 kg_{OC}/kg_{solid} (EC, 2003).

- Monolinuron has a log $K_{p,\ susp-water}$ < 3; derivation of $MPC_{sediment}$ is not triggered.
- Monolinuron has a log $K_{p,\ susp-water}$ < 3; expression of the MPC_{water} as $MPC_{susp,\ water}$ is not required.
- Monolinuron has a log K_{ow} < 3; assessment of secondary poisoning is not triggered.
- Monolinuron has an R 22, 48/22 classification, but the log K_{ow} is < 3. Therefore, derivation of an MPC_{water} for human health via food (fish) consumption ($MPC_{hh\ food,\ water}$) is not required.
- For monolinuron, no specific A1 value or Drinking Water Standard is available from Council Directives 75/440/EEC and 98/83/EC, respectively. Therefore, the general Drinking Water Standard for organic pesticides applies.

3.3 Toxicity data and derivation of ERLs for water

3.3.1 $MPC_{eco,\ water}$ and $MPC_{eco,\ marine}$

An overview of the selected freshwater toxicity data for monolinuron is given in Table 6.Detailed aquatic toxicity data for monolinuron are tabulated in Appendix 1. Marine toxicity data are not available.

Table 6. Monolinuron: selected freshwater toxicity data for ERL derivation.

Chronic[a]		Acute[a]	
Taxonomic group	**NOEC/EC10 (mg/L)**	**Taxonomic group**	**L(E)C50 (mg/L)**
Bacteria	11	Algae	0.20
Cyanobacteria	0.137	Algae	**0.001**
Cyanobacteria	0.26	Crustacea	33
Algae	0.125	Crustacea	30
Algae	**0.0015**	Annelida	150
Crustacea	0.95 [b]	Insecta	12.5
Pisces	5.0	Insecta	100
		Insecta	75
		Pisces	104.4
		Pisces	12.5
		Pisces	74
		Pisces	74
		Pisces	28.6
		Pisces	46
		Pisces	54

[a] For detailed information see Appendix 1. Bold values are used for ERL derivation.
[b] Geometric mean of 0.56 and 1.6 mg/L for *Daphnia magna* (Reproduction and/or survival).

3.3.1.1 Treatment of fresh- and saltwater toxicity data

ERLs for freshwater and marine waters should be derived separately. For pesticides, data can only be combined if it is possible to determine with high probability that marine organisms are not more sensitive than freshwater organisms (Lepper, 2005). For monolinuron, no marine toxicity data are available and ERLs for the marine compartment cannot be derived.

3.3.1.2 Mesocosm and field studies

No mesocosm studies are available.

3.3.1.3 Derivation of $MPC_{eco, water}$ and $MPC_{eco, marine}$

For monolinuron a complete base set for toxicity to freshwater organisms is available. Moreover, 7 long-term NOECs of three trophic levels (bacteria, algae, Crustacea and fish) are available. Therefore, the $MPC_{eco, water}$ is derived using an assessment factor of 10 on the lowest NOEC, i.e. the 72-h NOEC for *Scenedesmus subspicatus* of 0.0015 mg/L. The $MPC_{eco, water}$ is 0.0015 / 10 = 0.00015 mg/L (0.15 μg/L).

No $MPC_{eco, marine}$ can be derived because no data are available.

3.3.2 $MPC_{sp, water}$ and $MPC_{sp, marine}$

Monolinuron has a log K_{ow} < 3, thus assessment of secondary poisoning is not triggered.

3.3.3 $MPC_{hh food, water}$

Monolinuron has an R48/22 classification, but the log K_{ow} is < 3. Therefore, derivation of an MPC_{water} for human health via food (fish) consumption ($MPC_{hh food, water}$) is not required.

3.3.4 $MPC_{dw, water}$

The Drinking Water Standard is 0.1 μg/L. Thus, the $MPC_{dw, water}$ is also 0.1 μg/L.

3.3.5 Selection of the MPC_{water} and MPC_{marine}

The only included (see Section 2.3.1) is the ecotoxicological $MPC_{eco, water}$. Therefore, the MPC_{water} is 0.15 μg/L.

No MPC_{marine} can be selected due to the absence of data.

3.3.6 MAC_{eco}

3.3.6.1 $MAC_{eco, water}$

The $MAC_{eco, water}$ may be derived from the acute toxicity data. Fifteen short-term values for three trophic levels (fish, Crustacea, Annelida, Insecta and algae) are available, monolinuron has no potential to bioaccumulate (log K_{ow} < 3 L/kg), the mode of action for the tested species is specific and the potentially most sensitive species group (algae) is included in the data set. Therefore, an assessment factor of 10 is applied to the lowest $L(E)C_{50}$, i.e. the EC_{50} for *Scenedesmus subspicatus* of 0.001 mg/L. The MAC_{eco} is derived as 0.001 / 10 = 0.0001 mg/L (0.1 μg/L).
However, because the $MPC_{eco, water}$ (0.15 μg/L) is higher, the $MAC_{eco, water}$ is put level with the $MPC_{eco, water}$ (see INS-Guidance, section 4.1.4) and becomes 0.15 μg/L.

3.3.6.2 $MAC_{eco, marine}$

Because no data are available for marine organisms, no $MAC_{eco, marine}$ can be derived.

3.3.7 $SRC_{eco, water}$

Since more than three long-term NOECs of all required trophic levels are available, the $SRC_{eco, water}$ is derived from the geometric mean of all available NOECs with an assessment factor 1. The geometric mean is 0.321 mg/L, the $SRC_{eco, water}$ is 0.321 / 1 = 0.321 mg/L.

3.4 Toxicity data and derivation of ERLs for sediment

The log $K_{p, susp-water}$ of monolinuron is below the trigger value of 3; therefore, ERLs are not derived for sediment.

4 Conclusions

In this report, the risk limits Maximum Permissible Concentration (MPC), Maximum Acceptable Concentration for ecosystems (MAC_{eco}), and Serious Risk Concentration for ecosystems (SRC_{eco}) are derived for monolinuron in water. No risk limits were derived for the marine compartment because data were not available. Derivation of risk limits for sediment was not triggered.

The ERLs that were obtained are summarised in the table below. The MPC value that was set for this compound until now, is also presented in this table for comparison reasons.

Table 7. Derived MPC, MAC_{eco}, and SRC values for monolinuron.

ERL	Unit	MPC	MAC_{eco}	SRC
Water, old	µg/L	0.001[a]	-	-
Water, new[b]	µg/L	0.15	0.15	321
Drinking water[b]	µg/L	0.1[d]	-	-
Marine	µg/L	n.d.[c]	n.d.[c]	n.d.[c]

a MPC based on dissolved concentrations, source: RIVM/Risico's van stoffen http://www.rivm.nl/rvs/

b The $MPC_{dw, water}$ is reported as a separate value from the other MPC_{water} values ($MPC_{eco, water}$, $MPC_{sp, water}$ or $MPC_{hh food, water}$). From these other MPC_{water} values (thus excluding the $MPC_{dw, water}$) the lowest one is selected as the 'overall' MPC_{water}.

c n.d. = not derived due to lack of data

d provisional value pending the decision on implementation of the $MPC_{dw, water}$, (see Section 2.3.1)

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Veith GD, Defoe DL and Bergstedt BV. 1979. Measuring and estimating the bioconcentration of chemicals in fish. J Fish Res Board Can 36: 1040-1048.

Appendix 1. Detailed aquatic toxicity data

Table A1.1. Acute toxicity of monolinuron to freshwater organisms.

Species	Species properties	A	Test type	Test compound	Purity [%]	Test water	pH	T [°C]	Hardness $CaCO_3$ [mg/L]	Exp. time	Criterion	Test endpoint	Value [mg/L]	Ri	Notes	Reference
Algae																
Ankistrodesmus falcatus		N	S	Monolinuron		am				10 d	EC50	Cell density	0.44	3	11	Tscheu-Schlüter and Winter, 1985
Ankistrodesmus falcatus		N	S	Monolinuron		am				10 d	NOEC	Cell density	0.14	3	11	Tscheu-Schlüter and Winter, 1985
Chlorella		N		Monolinuron		am				96 h	EC50	Growth rate	0.20	2	13	Van de Plassche and Linders, 1990; unpublished data, 1982
Chlorella		N		Monolinuron		am				96 h	NOEC	Growth rate	< 0.2	2		Knauf and Shultze, 1972
Chlorella fusca		N		Monolinuron							EC50	Cell reproduction	0.22	3	7	Manthey et al., 1993
Scenedesmus subspicatus		N	S	Monolinuron	96.2	am	7.0	24±2		96 h	EC50	Cell density	0.001	2	13	EC, 1996
Scenedesmus subspicatus		N	S	Aresin 48 WP	50	am				72 h	EC50	Cell density	0.018	3	1	EC, 1996
Scenedesmus subspicatus		N	S	Aresin 48 WP	50	am				72 h	NOEC	Cell density	0.0015	2	2	EC, 1996
Scenedesmus subspicatus		N	S	Aresin 48 WP	50	am				72 h	NOEC	Cell density	< 0.0009	2		EC, 1996
Scenedesmus subspicatus		N		Monolinuron	>95	am				96 h	EC50	Growth rate	0.001	2	13	Van de Plassche and Linders, 1990; unpublished data, 1982
Macrophyta																
Lemna				Monolinuron							LC50		2.4	3	9	Knauf and Schulze, 1972
Crustacea																
Asellus aquaticus		N		Aresin	51.7					24 h	LC50	Mortality	> 100	2		Lüdemann and Kayser, 1966 (v.d.Plassche and Linders)
Carinogammarus roeselli		N		Aresin	51.7					24 h	LC50	Mortality	30	2	13	Lüdemann and Kayser, 1966 (v.d.Plassche and Linders)
Daphnia magna		N	S	Monolinuron						48 h	EC50	Immobility	33	2	13	EC, 1996
Daphnia magna		N	S	Monolinuron						48 h	NOEC	Immobility	19	2		EC, 1996
Daphnia magna				Monorotox		dtw				96 h	LC50	Mortality	1.3	3	10	Knapek and Lakota, 1974
Daphnia magna		N		Monolinuron	96.2					48 h	EC50	Immobility	33.0	4*		Van de Plassche and Linders, 1990; unpublished data, 1983
Daphnia magna	Neonates	N	S	Aresin 48 WP	50		7.8-8.3	21.7-21.9		48 h	EC50	Immobility	3.86	3	6	EC, 1996
Daphnia magna		N		Aresin	51.7					24 h	LC50	Mortality	30	3	12	Lüdemann and Kayser, 1966 (v.d.Plassche and Linders)
Annelida																
Tubifex spec.		N		Monolinuron						24 h	LC50	Mortality	90	3	8	Knauf and Schulze, 1972
Tubifex tubifex		N		Aresin	51.7					24 h	LC50	Mortality	150	2	13	Lüdemann and Kayser, 1966
Insecta																
Aedes aegipti				Aresin	51.7					24 h	LC50	Mortality	75	2	13	Lüdemann and Kayser, 1966 (v.d.Plassche and Linders)
Chironomus plumosus				Aresin	51.7					24 h	LC50	Mortality	100	2	13	Lüdemann and Kayser, 1966 (v.d.Plassche and Linders)
Chironomus tentans		N		Aresin 50%	50		8.3	24.5-25.5	70	48 h	LC50	Mortality	12.5	2	13	Dad and Tripathi, 1980
Chironomus thummi				Monolinuron						24 h	LC50	Mortality	> 100	3	8	Knauf and Schulze, 1972
Mollusca																
Limnea stagnalis		N		Monolinuron						24 h	LC50	Mortality	85	3	8	Knauf and Schulze, 1972
Pisces																
Carassius carassius				Monorotox		dtw				96 h	LC50	Mortality	27.8	3	10	Knapek and Lakota, 1974
Channa punctatus	8.7 g	N	S	Aresin		nw	8.5	28.5		96 h	LC50	Mortality	104.4	2	13	Rao and Dad, 1979
Cirrhinus mrigala	5.0 g	N	S	Aresin 50%		nw	8.5	28.5		96 h	LC50	Mortality	12.5	2	13	Dad and Tripathi, 1980
Cyprinus carpio		Y	S	Monolinuron						96 h	LC50	Mortality	74	2		EC, 1996
Cyprinus carpio		Y	S	Aresin 48 WP	50					96 h	LC50	Mortality	40	3	4,5	EC, 1996
Cyprinus carpio				Monorotox		dtw				96 h	LC50	Mortality	12.9	3	10	Knapek and Lakota, 1974
Cyprinus carpio			S	Monolinuron						96 h	LC50	Mortality	74	4*		Van de Plassche and Linders, 1990; unpublished data, 1982
Leuciscus ides melanotus	1.5 g, 5-7 cm	N	S	Monolinuron		dtw	7-8	20±1	255	48 h	LC50	Mortality	74	2	13	Juhnke and Lüdemann, 1978
Mystus vittatus	5.0 g	N	S	Aresin 50%		nw	8.5	28.5		96 h	LC50	Mortality	28.6	2	13	Dad and Tripathi, 1980
Oncorhynchus mykiss		Y	S	Monolinuron						96 h	LC50	Mortality	56	3	3	EC, 1996
Oncorhynchus mykiss		Y	S	Aresin 48 WP	50					96 h	LC50	Mortality	50.2	3	5	EC, 1996

Species	Species properties	A	Test type	Test compound	Purity [%]	Test water	pH	T [°C]	Hardness $CaCO_3$ [mg/L]	Exp. time	Criterion	Test endpoint	Value [mg/L]	Ri	Notes	Reference
Oncorhynchus mykiss				Monorotox		dtw				96	LC50	Mortality	3.1	3	10	Knapek and Lakota, 1974
Poecilia reticulata		N	S	Monolinuron		am				96 h	LC50	Mortality	46	2	13	Tscheu-Schlüter and Winter, 1985
Poecilia reticulata		N	S	Monolinuron		am				96 h	NOEC	Mortality	1	2		Tscheu-Schlüter and Winter, 1985
Sarotherodon mossambicus	5.25 g	N	S	Aresin		nw	8.5	28.5		96 h	LC50	Mortality	54	2	13	Rao and Dad, 1979
Tincia tincia				Monorotox		dtw				96 h	LC50	Mortality	25.0	3	10	Knapek and Lakota, 1974

NOTES

1 According to OECD 201. Average of 3 separate tests; result > 3 x value of a.s.
2 Result of 2 separate tests.
3 Value corrected for 56% actual test concentration. Initial concentration too low.
4 Value corrected for 59% actual test concentration. Initial concentration too low.
5 Not clear whether the value is expressed as a.s.
6 Result 3 x smaller than value of a.s.
7 Experiment poorly described; unit of EC50 not given, probably mol/L.
8 No test details are given. These values are shown as indicative for Annelida, Insecta and Mollusca.
9 No test details are given. This value is shown because it is the only value available for aquatic Macrophyta.
10 Insufficient experimental data reported.
11 Study period too long.
12 Study period too short
13 Monolinuron is sufficiently stable to accept nominal values.

Table A1.2. Chronic toxicity of monolinuron to freshwater organisms.

Species	Species properties	A	Test type	Test compound	Purity [%]	Test water	pH	T [°C]	Hardness $CaCO_3$ [mg/L]	Exp. time	Criterion	Test endpoint	Value [mg/L]	Ri	Notes	Reference
Bacteria																
Pseudomonas putida				Monolinuron		am		25		16 h	NOEC	Cell density	11	2	3,8	Bringmann and Kühn, 1977
Cyanobacteria																
Microcystis aeruginosa				Monolinuron		am		27		8 d	NOEC	Cell density	0.14	4*		Bringmann and Kühn, 1978
Microcystis aeruginosa				Monolinuron		am					NOEC	Cell density	0.137	2	8	Bringmann and Kühn, 1975
Nostoc spec.				Monolinuron		am				8 d	NOEC	Growth	0.26	2	8	Bringmann and Kühn, 1975
Algae																
Ankistrodesmus falcatus		N	S	Monolinuron		am				10 d	NOEC	Cell density	0.14	3	4	Tscheu-Schlüter and Winter, 1985
Chlorella		N		Monolinuron		am				96 h	NOEC	Growth rate	< 0.2	2		Knauf and Shultze, 1972
Scenedesmus quadricauda		N	S	Aresin		am				14 d	NOEC	Chlorophyll	> 0.1	3	2	Pawlaczyk-Szpilowa et al., 1972
Scenedesmus quadricauda				Monolinuron		am					NOEC	Growth	0.125	2	8	Bringmann and Kühn, 1974
Scenedesmus quadricauda				Monolinuron		am		27		8 d	NOEC	Cell density	0.13	4*		Bringmann and Kühn, 1977
Scenedesmus subspicatus		N	S	Aresin 48 WP	50	am				72 h	NOEC	Cell density	0.0015	2	1,5,8	EC, 1996
Scenedesmus subspicatus		N	S	Aresin 48 WP	50	am				72 h	NOEC	Cell density	< 0.0009	2		EC, 1996
Mollusca																
Lymnea stagnalis			F	Monolinuron						28 d	NOEC	Mortality	0.1	3	7	Knauf and Shultze, 1972
Annelida																
Tubifex spec.			f	Monolinuron						28 d	NOEC	Mortality	> 1	3	7	Knauf and Shultze, 1972
Crustacea																
Daphnia magna		Y	R	Monolinuron	97.6		7.6-8.2	19.5-20.0		21 d	NOEC	Reproduction/survival	0.56	2		EC, 1996
Daphnia magna		Y	R	Aresin 48 WP	50		7.4-8.3	19.7-20.2		21 d	NOEC	Reproduction	1.6	2		EC, 1996
Pisces																
Cyprinus carpio			F	Monolinuron						28 d	NOEC	Mortality	> 1	3	7	Knauf and Shultze, 1972
Lebistes reticulatus	5.5 m old	Y	S	Aresin	51.7					80 d	NOEC	Mortality	< 8	2		Niehuss, 1967 (v.d.Plassche and Linders)
Oncorhynchus mykiss	m 5 cm, m 2.2 g	Y	F	Monolinuron	97.6		7.6-8.2	13.2-14.4		21 d	NOEC	Emaciation	5.0	2	6, 10	EC, 1996
Oncorhynchus mykiss		Y	F	Aresin 48 WP	50		7.6-8.1	12.4-15.4		21 d	NOEC	Feeding activity	2.7	2	9	EC, 1996

NOTES

1 Result of 2 separate tests.
2 Percentage a.s. in test substance unclear; poor description of experiment; test duration too long.
3 Growing conditions.
4 Experimental period too long.
5 According to OECD 201.
6 According to OECD 204.
7 No details of the test were given.
8 Monolinuron is sufficiently stable to accept nominal values.
9 Non-relevant endpoint; not taken up in the aggregated data table.
10 Relevant endpoint: on prolonged exposure emaciation can lead to death

Appendix 2. References used in the appendices

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