National Institute
for Public Health
and the Environment

Letter report 601716003/2008
J.W.A. Scheepmaker

Environmental risk limits for abamectin

rivm

RIVM Letter report 601716003/2008

Environmental risk limits for abamectin

Jacqueline Scheepmaker

Contact:
Jacqueline Scheepmaker
Expertise Centre for Substances
Jacqueline.Scheepmaker@rivm.nl

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".

rivm

Rapport in het kort

Environmental risk limits for abamectin

Dit rapport geeft milieurisicogrenzen voor het insecticide/acaricide abamectine 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.

rivm

Contents

rivm

1. Introduction

1.1 Background and scope of the report

In this report, environmental risk limits (ERLs) for surface water (freshwater and marine) are derived for the insecticide /acaricide abamectin. 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). Abamectin is part of a series of 25 pesticides that appeared to have a high environmental impact on the evaluation of the policy document on sustainable crop protection ('Tussenevaluatie van de nota Duurzame Gewasbescherming'; MNP, 2006) and/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.

1.3 Data collection

In accordance with the WFD, data of existing evaluations were used as a starting point. For abamectin, the evaluation report prepared within the framework of EU Directive 91/414/EC (Draft Assessment Report, DAR) was consulted (EC, 2006; 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.

1.4 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 (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). Endpoints from tests with formulated products were not selected if the results (expressed on the basis of the active substance) differed by more than a factor of 3 from the results obtained with the active substance itself.

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.

1.5 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} and the derivation of the $MAC_{eco,\ marine}$ some additional comments should be made:

1.5.1 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 depends 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 (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.

1.5.2 $MAC_{eco, marine}$

The assessment factor for the $MAC_{eco, marine}$ value is based on

- the assessment factor for the $MAC_{eco, water}$ value when acute toxicity data for at least two specific marine taxa are available, or
- using an additional assessment factor of 5 when acute toxicity data for only one specific marine taxon are available (analogous to the derivation of the MPC according to Van Vlaardingen and Verbruggen, 2007), or
- using an additional assessment factor of 10 when no acute toxicity data are available for specific marine taxa.

If freshwater and marine data sets are not combined (which is generally the case for pesticides) the $MAC_{eco, marine}$ is derived on the marine toxicity data using the same additional assessment factors as mentioned above. It has to be noted that this procedure is currently not agreed upon. Therefore, the $MAC_{eco, marine}$ value needs to be re-evaluated once an agreed procedure is available.

3. Derivation of environmental risk limits for abamectin

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

1.6.1 Identity

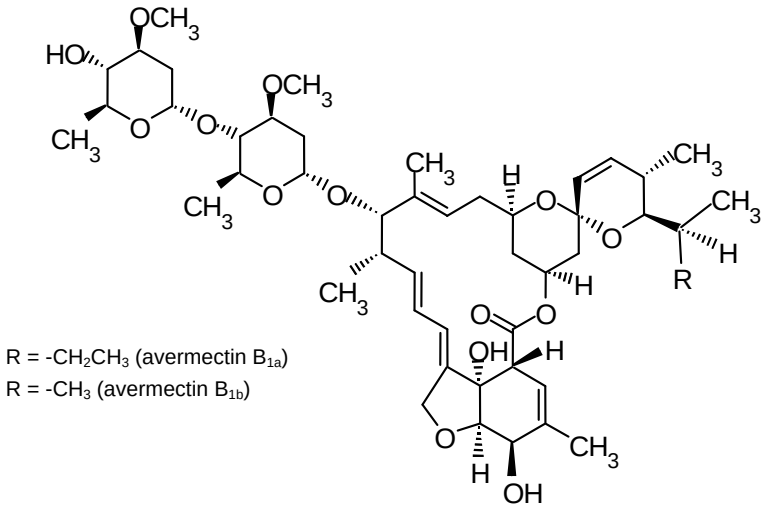

Figure 1. Structural formula of abamectin.

Avermectin B_{1a} is the major compound in abamectin, the other minor component is avermectin B_{1b}. Both components differ only by having an ethylgroup (B_{1a}) or a methylgroup (B_{1b}) at the 26-C position. Because the content of avermectin B_{1a} in abamectin is ≥ 80 %, and given the small difference in structure, the laboratory results obtained with avermectin B_{1a} are considered representative for abamectin.

Table 1. Identification of abamectin.

Parameter	Name or number	Source
Common/trivial/other name	abamectin; avermectin B_1 (mixture of ≥ 80% avermectin B_{1a} en < 20% avermectin B_{1b})	EC, 2006
Chemical name	Avermectin B_{1a}: (10*E*,14*E*,16*E*,22*Z*)-(1*R*,4*S*,5'*S*,6*S*,6'*R*,8*R*,12*S*,13*S*,20*R*,21*R*,24*S*)-6'-[(*S*)-*sec*-butyl]-21,24-dihydroxy-5',11,13,22-tetramethyl-2-oxo-3,7,19-trioxatetracyclo[15.6.1.$1^{4,8}$.$0^{20,24}$]pentacosa-10,14,16,22-tetraene-6-spiro-2'-(5',6'-dihydro-2'*H*-pyran)-12-yl 2,6-dideoxy-4-*O*-(2,6-dideoxy-3-*O*-methyl- α -L-*arabino*-hexopyranosyl)-3-*O*-methyl-α-L-*arabino*-hexopyranoside (i) Avermectin B_{1b}: (10*E*,14*E*,16*E*,22*Z*)-(1*R*,4*S*,5'*S*,6*S*,6'*R*,8*R*,12*S*,13*S*,20*R*,21*R*,24*S*)-21,24-dihydroxy-6'-isopropyl-5',11,13,22-tetramethyl-2-oxo-3,7,19-trioxatetracyclo[15.6.1.$1^{4,8}$.0^{20},24]pentacosa-10,14,16,22-tetraene-6-spiro-2'-(5',6'-dihydro-2'*H*-pyran)-12-yl 2,6-dideoxy-4-*O*-(2,6-dideoxy-3-*O*-methyl- α -L-*arabino*-hexopyranosyl)-3-*O*-methyl- α -L-*arabino*-hexopyranoside (ii) (4:1)	EC, 2006
CAS number	abamectin: 71751-41-2 avermectin B_{1a}: 65195-55-3 avermectin B_{1b}: 65195-56-4	EC, 2006
EC number	265-610-3 (abamectin)	ESIS
SMILES code	avermectin B_{1a}: O=C4C6C7(C(C(C(C6)C)O)OCC7=CC=CC(C(C(=CCC2OC3(CC(O4)C2)OC(C(CC)C)C(C=C3)C)C)OC5OC(C)C(C(C5)OC)OC1OC(C(C(C1)OC)O)C)C)O	
Use class	Insecticide and acaricide	EC, 2006
Mode of action	Contact and stomach action. Paralysis followed by mortality. Possibly binding with neural chloride channels.	EC, 2006
Authorised in NL	Yes	
Annex 1 listing	No	

1.6.2 Physico-chemical properties

Table 2. Physico-chemical properties of abamectin.

Parameter	Unit	Value	Remark	Reference
Molecular weight	[g/mol]	873.1 859.1	avermectin B_{1a} avermectin B_{1b}	EC, 2006
Water solubility	[mg/L]	1.21 ± 0.15	pH 7.57, 25 ºC	EC, 2006
pK_a	[-]	no dissociation	pH 1-12	EC, 2006
log K_{OW}	[-]	4.4 ± 0.3	pH 7.2, 20 ºC	EC, 2006
log K_{OC}	[-]	3.75	Koc 5638 L/kg (mean of 7 soils)	EC, 2006
Vapour pressure	[Pa]	<3.7 x 10^{-6}		EC, 2006
Melting point	[°C]	161.8-169.4	purity 96.7%	EC, 2006
Boiling point	[°C]	n.d.		EC, 2006
Henry's law constant	[Pa.m^3/mol]	≤ 2.7 x 10^{-3}		EC, 2006

n.a. = not applicable
n.d. = not determined

1.6.3 Behaviour in the environment

Table 3. Selected environmental properties of abamectin.

Parameter	Unit	Value	Remark	Reference
Hydrolysis half-life	DT50 [d]	no hydrolysis	pH 4-7, 25 ºC, avermectin B_{1a}	EC, 2006
Photolysis half-life	DT50 [d]	1.3	natural sunlight	EC, 2006
Readily biodegradable		no	avermectin B_{1a}	EC, 2006
Water/sediment	DT50 [d]	89	whole system	EC, 2006
Relevant metabolites	[8,9-Z]-avermectin B_{1a} (NOA 427011), 4"-oxo-avermectin B_{1a} (NOA 426289)			EC, 2006

1.6.4 Bioconcentration and biomagnification

An overview of the bioaccumulation data for abamectin is given in Table 4. Detailed bioaccumulation data for abamectin are tabulated in Appendix 1.

Table 4. Overview of bioaccumulation data for abamectin.

Parameter	Unit	Value	Remark	Reference
BCF (fish)	[L/kg]	67.6	Geometric mean of 69, 56 and 80 L/kg for whole fish	see Appendix 1
BMF	[kg/kg]	1	Default value for BCF < 2000 L/kg	

1.6.5 Human toxicological threshold limits and carcinogenicity

The following R-phrases were proposed for abamectin: R26, R28, R60, R61, R62 (EC, 2006). An ADI of 0.0012 mg/kg_{bw}/d is proposed in the DAR, based on a number of toxicity studies with NOEL values of 0.25 mg/kg_{bw}/d (EC, 2006).

1.7 Trigger values

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

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

Parameter	Value	Unit	Method/Source	Derived at section
log $K_{p,susp\text{-}water}$	2.75	[-]	$K_{OC} \times f_{OC,susp}$ [1]	K_{OC}: 1.6.2
BCF	67.6	[L/kg]		1.6.4
BMF	1	[kg/kg]		1.6.4
Log K_{OW}	4.4	[-]		1.6.2
R-phrases	R26, 28, 60, 61, 62, 63, 50/R53	[-]		1.6.5
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).

- abamectin has a log $K_{p,\ susp\text{-}water}$ < 3; derivation of $MPC_{sediment}$ is not triggered.
- abamectin has a log $K_{p,\ susp\text{-}water}$ < 3; expression of the MPC_{water} as $MPC_{susp,\ water}$ is not required.
- abamectin does have a BCF < 100 L/kg; assessment of secondary poisoning is not triggered.
- abamectin has an R60, R61, R62 and R63 classification. Therefore, an MPC_{water} for human health via food (fish) consumption ($MPC_{hh\ food,\ water}$) should be derived.
- For abamectin, 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.

1.8 Toxicity data and derivation of ERLs for water

1.8.1 $MPC_{eco, water}$ and $MPC_{eco, marine}$

An overview of the selected freshwater toxicity data for abamectin is given in Table 6. Marine data are given in Table 7. Detailed toxicity data for abamectin are tabulated in Appendix 2.

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

Chronic[a]		**Acute**[a]	
Taxonomic group	**NOEC/EC10 (µg/L)**	**Taxonomic group**	**L(E)C50 (µg/L)**
Algae	> solubility	**Algae**	> solubility
Crustacea		**Crustacea**	
Daphnia magna	**0.01**[h]	*Daphnia magna*	0.42[b]
Pisces		*D. galatea*	0.55
Cyprinus carpio	6.10	*D. longispina*	0.38
Oncorhynchus mykiss	0.52[i]	*D. pulex*	**0.18**[c]
		Diaphanosoma sp.	0.53
		Gammarus sp.	7.30[d]
		Simocephalus sp.	0.30
		Thamnocephalus platyurus	2.8
		Insecta	
		Aedes aegypti	4.80
		A. taeniorhynchus	0.70
		Anophales albimanus	2.21
		A. quadrimaculatus	6.60
		Chaoborus sp.	88.26[e]
		Chironomus crassicaudatus	1.63
		Cloeon sp.	2.90
		Culex quinquefasciatus	27[f]
		C. nigipalpus	7.84
		C. salinarius	7.59
		Glyptotendipes paripes	1.52
		Wyeomyia mitchelli	2.25
		Mollusca	
		Lymnaea stagnalis	55
		Pisces	
		Cyprinus carpio	42
		Ictalurus punctatus	24
		Lepomus macrochirus	7.2
		Oncorhynchus mykiss	5.7[g]
		Pimephales promelas	14.7

[a] For detailed information see Appendix 2. Bold values are used for ERL derivation.
[b] geomean of 0.34, 0.37, 0.56, 0.30, 0.63; endpoint mortality
[c] geomean of 0.12 and 0.28 µg/L; endpoint mortality
[d] geomean of 6.2 and 8.6 µg/L; endpoint immobilisation
[e] geomean of 190 and 41 µg/L; endpoint immobilisation
[f] endpoint mortality; most relevant duration (72 h)
[g] geomean of 3.6 and 8.7 µg/L; endpoint mortality
[h] most sensitive endpoint, parameter reproduction
[i] most sensitive endpoint, parameter weight

Table 7. Abamectin: selected marine toxicity data for ERL derivation.

Chronic[a]		Acute[a]	
Taxonomic group	**NOEC/EC10(µg/L)**	**Taxonomic group**	**L(E)C50(µg/L)**
Crustacea		**Crustacea**	
Mysidopsis bahia	**0.0035**	*Callinectes sapidus*	153
		Mysidopsis bahia	**0.045**[b]
		Penaeus duorarum	1.6
		Mollusca	
		Crassostrea virginica	430
		Pisces	
		Cyprinodon variegatus	15

[a] For detailed information see Appendix 2. Bold values are used for ERL derivation.
[b] geomean of 0.210, 0.022 and 0.020 µg/L; endpoint mortality

1.8.1.1 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). There a not enough marine data available to determine with high probability that marine organisms are not more sensitive to abamectin than freshwater organisms. Thus, the datasets are treated separately.

1.8.1.2 Mesocosm and field studies

In the DAR two outdoor microcosm studies are summarised, for a more detailed description see Appendix 3.

In the first study, the effects of a single application of Vertimec 0.18 EC were studied in a mesocosm where phytoplankton, zooplankton and emerging insects were studied. In the summary of the DAR, the DT_{50}-value was estimated to be 9-10 days. Actual concentrations in the highest treatment of 17 µg as/L were 10.4-12.7 µg/L after 24 hours and declined to 5-6 µg as/L after two weeks and to 0.8-0.9 µg as/L after three weeks. Actual concentrations in the lower treatments were not reported. Since the exposure was not continuous during the experiment, the reported NOEC and NOEAEC can not be used for chronic MPC-derivation.
For acute effects of the application the summary concludes to a NOEC of 0.066 µg as/L. This NOEC is based on effects on several groups of zooplankton and phytoplankton in the next higher concentration. In the 0.066 µg as/L treatment some significant differences with the control were found. Since these differences are not treatment related, the NOEC for acute effects derived from this study is 0.066 µg as/L. This value is considered for derivation of the $MAC_{eco, water}$.

In the second study, the formulation Vertimec (19.5% as) was applied three times with weekly intervals. The median dissipation time after the third application was estimated to be 4.3-5.8 days. Thus, also in this study the exposure was not continuous and the reported NOEC and NOEAEC can not be used for chronic MPC-derivation. At 3 x 0.045 µg as/L clear treatment related effects were found for zooplankton and phytoplankton. In the next lower treatment 3 x 0.015 µg as/L significant effects were found, but these were not treatment related. At the exposure level of 3 x 0.015 µg as/L, the actual concentration one day after the last application was 0.016 µg as/L (average of 3 replicate cosms). There are indications that there is a cumulation of effects (e.g. effects are only found after the third treatment), although concentrations are not accumulative. Therefore, the NOEC after repeated applications for the MAC represents a worst case estimate of the NOEC for acute effects, and the value of 0.016 µg as/L is considered as such for derivation of the $MAC_{eco, water}$.

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

Acute toxicity data are available for crustacea, insecta, mollusca and fish. Algae were tested, but no valid endpoint could be determined since effects, if present, were only observed at concentrations that were well above water solubility (> 1210 µg/L). It is considered justified to treat the data as if the base set is complete and the use of chronic toxicity data can therefore be allowed. Long-term defined NOECs are available for crustacea and fish. The NOEC for algae is well above the solubility. Thus data on NOECs of three trophic levels are present and therefore an assessment factor of 10 can be applied to the lowest NOEC of 0.01 µg/L for crustacea. The $MPC_{eco, water}$ is 0.01/10 = 0.001 µg/L.

For the marine environment, acute toxicity data are available for crustacea, mollusca and fish. Data on algae are missing. Abamectin is an insecticide with a specific working mechanism, acting via contact and stomach action and causing paralysis. It is therefore considered justified to assume that marine algae are equally insensitive to this compound as observed for freshwater, and treat the data as would have been done with a complete base set. For the derivation of the $MPC_{eco, marine}$ one long-term marine NOEC is available for crustacean (NOEC 0.0035 µg/L for *Mysidopsis bahia*). No NOECs are available for additional specific marine taxonomic groups (e.g. echinoderms, marine molluscs). Because *M. bahia* was also the species showing the lowest acute EC_{50}, an assessment factor of 1000 is applied to the NOEC of 0.0035 µg/L. The $MPC_{eco, marine}$ becomes 0.0035/1000 = 3.5×10^{-6} µg/L.

1.8.2 $MPC_{sp, water}$ and $MPC_{sp, marine}$

Abamectin has a BCF < 100 L/kg, thus assessment of secondary poisoning is not triggered.

1.8.3 $MPC_{hh\ food, water}$

Derivation of $MPC_{hh\ food, water}$ for abamectin is triggered (Table 5). With an ADI of 0.0012 $mg/kg_{bw}/d$ (Section 3.1.5), a BCF of 67.6 L/kg and a BMF of 1 (section 3.1.4), the $MPC_{hh, food}$ becomes (0.1 × 0.0012 × 70) / 0.115 = 0.073 mg/kg. Subsequently, the $MPC_{hh\ food, water}$ = 0.073 / (67.6 × 1) = 1.08×10^{-3} mg/L (1.08 µ/L).

1.8.4 $MPC_{dw, water}$

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

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

For freshwater the lowest value of the routes included (see Section 2.3.1) is the ecotoxicological $MPC_{eco, water}$. The MPC_{water} is 0.001 µg/L.

For the marine environment, the lowest value of the routes included is the $MPC_{eco, marine}$. The MPC_{marine} is 3.5×10^{-6} µg/L.

1.8.6 MAC_{eco}

1.8.6.1 $MAC_{eco, water}$

As explained above in Section 3.3.1.3, the acute base set can be assumed to be complete. In the freshwater data set, crustacea are most sensitive as compared to other species groups, including insects. The most sensitive species in the data set is *Daphnia pulex* with an EC_{50} value of 0.18 µg/L. Abamectin has no potential to bioaccumulate, the mode of toxic action is known, and it is assumed that the most sensitive species group is included in the data set. Therefore, an assessment factor of 10 can be used. The $MAC_{eco, water}$ is initially set to 0.018 µg/L.

A NOEC of 0.016 µg/L is available from a mesocosm studies (see Section 3.3.1.2). The NOEC of 0.016 µg/L is considered as a worst case NOEC, because three applications were applied. Because of

this and since a second study with a higher NOEC (0.066 µg/L) is available, no safety factor is needed and the $MAC_{eco, water}$ based on mesocosms is 0.016 µg/L. Since this value is close to the $MAC_{eco, water}$ derived with the laboratory studies, the $MAC_{eco, water}$ is kept at 0.018 µg/L.

1.8.6.2 $MAC_{eco, marine}$

One specific marine taxon is available (mollusca: acute) and thus an assessment factor of 5 is used additional to the assessment factor of 10 that was used for the $MAC_{eco, water}$ (provisional method, see Section 2.3.2). A total assessment factor of 50 is put on the lowest marine $L(E)C_{50}$ of 0.045 µg/L. The provisional $MAC_{eco, marine}$ is set to 9.0×10^{-4} µg/L.

1.8.7 SRC_{eco}

1.8.7.1 $SRC_{eco, water}$

Chronic data are available for algae, crustacea and fish and the geometric mean of the chronic data (0.01, 6.10 and 0.52 µg/L) is 0.317 µg/L. As NOECs are available for three trophic levels an assessment factor of 1 can be applied to the geometric mean of 0.32 µg/L. The $SRC_{eco, water}$ is 0.32 µg/L.

1.9 Toxicity data and derivation of ERLs for sediment

The available sediment toxicity data are given in Appendix 4. However, the log $K_{p, susp-water}$ of abamectin 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 abamectin in fresh- and marine water. 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. It should be noted that this is an indicative MPC ('ad-hoc MTR'), derived using a different methodology and based on limited data.

Table 8. Derived MPC, MAC_{eco}, and SRC values for abamectin.

ERL	Unit	MPC	MAC_{eco}	SRC
Water, old [a]	µg/L	4.0×10^{-5}		
Water, new [b]	µg/L	1.0×10^{-3}	0.018	0.32
Drinking water[b]	µg/L	0.1[c]	-	-
Marine	µg/L	3.5×10^{-6}	9.0×10^{-4}[d]	-

[a] indicative MPC ('ad-hoc MTR'), source: Helpdesk Water http://www.helpdeskwater.nl/emissiebeheer/normen_voor_het/zoeksysteem_normen/

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

[d] provisional value, pending agreement on the derivation procedure (see Section 2.3.2)

rivm

References

EC. 2003. Technical Guidance Document in support of Commission Directive 93/67/EEC on Risk Assessment for new notified substances, Commission Regulation (EC) No 1488/94 on Risk Assessment for existing substances and Directive 98/9/EC of the European Parliament and of the Council concerning the placing of biocidal products on the market. Part II. Ispra, Italy: European Chemicals Bureau, Institute for Health and Consumer Protection. Report no. EUR 20418 EN/2.

EC. 2006. Abamectin, Draft Assessment Report. Rapporteur Member State: The Netherlands. Public version, June 2006.

Lepper P. 2005. Manual on the Methodological Framework to Derive Environmental Quality Standards for Priority Substances in accordance with Article 16 of the Water Framework Directive (2000/60/EC). 15 September 2005 (unveröffentlicht) ed. Schmallenberg, Germany: Fraunhofer-Institute Molecular Biology and Applied Ecology.

MNP. 2006. Tussenevaluatie van de nota Duurzame gewasbescherming. Bilthoven, The Netherlands: Milieu- en Natuurplanbureau. MNP-publicatienummer: 500126001.

Tomlin CDS. 2002. e-Pesticide Manual 2002-2003 (Twelfth edition) Version 2.2. British Crop Protection Council.

Van Vlaardingen PLA, Verbruggen EMJ. 2007. Guidance for the derivation of environmental risk limits within the framework of the project 'International and National Environmental Quality Standards for Substances in the Netherlands' (INS). Bilthoven, The Netherlands: National Institute for Public Health and the Environment (RIVM). Report no. 601782001. 146 pp.

rivm

Appendix 1. Information on bioconcentration

Species	Species properties	Test substance	Purity [%]	A	Test type	Test water	pH	Temp. [°C]	Exp. time	Exp. concn. [µg/L]	BCF [$L/kg_{w.w.}$]	BCF type	Calculation method	Ri	Notes	Reference
Lepomis macrochirus	55 mm	5-3H-avermection B_{1a}		Y	F				28-14	0.099±0.019	69	whole fish	k1/k2	2	1,3	DAR; Forbis and Franklin, 1983
Lepomis macrochirus	55 mm	5-3H-avermection B_{1a}		Y	F		7.9-8.2	21-22	28-14	0.099±0.019	56	whole fish	k1/k2	2	1	Van den Heuvel et al. 1996
Lepomis macrochirus	46 mm	5-3H-avermection B_{1a}	>98	Y	F	nw	8.1	22	28-14	1.2	80	whole fish	k1/k2	2		Chukwudebe et al. 1996
Acipenser or Huso sp.(sturgeon)	20.3 ± 1.6 cm	avermectin B_1	92	Y	F		7.4-7.8	20 ± 1	22-18	0.0002	42	muscle	k1/k2	3	2	Shen et al, 2005
Acipenser or Huso sp.(sturgeon)	20.3 ± 1.6 cm	avermectin B_1	92	Y	F		7.4-7.8	20 ± 1	22-18	0.001	41	muscle	k1/k2	3		Shen et al, 2005

NOTES
1 ASTM 1978
2 92% avermectin B1a and 6% avermectin B1b
3 Hamelink, 1977

Appendix 2. Detailed aquatic toxicity data

Table A2.1. Acute toxicity of abamectin 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 [µg/L]	Ri	Notes	Reference
Algae																
Chlorella pyrenoidosa		N	S	avermectin B1	95	am				96 h	growth	EC50	9888	3	1,20	Ma, Zhen, Xu and Wang, 2002
Pseudokirchneriella subcapitata	1 x 10^4 cells/mL	Y	S	formulation	1.9	am	7.6-9.9	22.5-24.0		72 h	growth	EC50	>1590	2	1,2,4,12	EC, 2006
Scenedesmus obliqnus		N	S	avermectin B1	95	am				96 h	growth	EC50	7310	3	1,20	Ma, Zhen, Xu and Wang, 2002
Crustacea																
Brachionus calciflorus		N	S	abamectin tech.	89.3	rw	8.2	25		24 h	mortality	LC50	36000	3	21,2	EC, 2006 (Knauer, 2001d)
Brachionus calciflorus		Y	S	abamectin tech.	89.3	rw	8.2	24 ± 1		24 h	mortality	LC50	4000	3	2,6,20,21	EC, 2006 (Knauer, 2001e)
Daphnia galeata		N	S	abamectin tech.	89.3	nw	8.3	20	86	48 h	mortality	LC50	0.550	2	21,23	EC, 2006 (Knauer, 2001a)
Daphnia longispina		Y	S	abamectin tech.	89.3	nw	8	20	100	48 h	mortality	LC50	0.380	2	2,21,23	EC, 2006 (Knauer, 2001b)
Daphnia magna	<24 h old	N	S	abamectin	91.4	rw	8	21.0	165	48 h	mortality	LC50	0.34	2	23	EC, 2006 (Surprenant, 1981)
Daphnia magna	<24 h old	Y	S	3H-abamectin	11.3	nw	8	21.0	174	48 h	mortality	LC50	0.37	2	1,2,23	EC, 2006 (Forbis, 1989a)
Daphnia magna	<24 h old	Y	S	3H-abamectin		nw	8	21.0	170	48 h	mortality	LC50	0.26	3	1,2,19,23	EC, 2006 (Forbis, 1989b)
Daphnia magna	<24 h old	Y	S	abamectin tech.	88.5	am	8	20	260	48 h	mortality	LC50	0.560	2	1,3,21,23	EC, 2006 (Rufli, 1998)
Daphnia magna	<24 h old	N	S	abamectin		am	8	20.0	170	48 h	mortality	LC50	0.30	2	23	EC, 2006 (Naimie, Anton, Kaelin, 1985)
Daphnia magna	<24 h old	N	S	abamectin B1a		am	8	20.0	170	48 h	mortality	LC50	0.63	2	23	EC, 2006 (Naimie, Anton, Kaelin, 1985)
Daphnia magna	<24 h old	Y	F	formulation	2.02	nw	8.2-8.3	20 ± 1	170	48 h	mortality	LC50	0.59	3	12,21,24,30	EC, 2006 (Putt, 1997)
Daphnia pulex		Y	S	abamectin tech.	89.3	nw	8	20	100	48 h	mortality	LC50	0.120	2	2,21,23	EC, 2006 (Knauer, 2001b)
Daphnia pulex		N	S	abamectin tech.	89.3	nw	8.5	20	84	48 h	mortality	LC50	0.280	3	21,23	EC, 2006 (Knauer, 2001c)
Diaphanosoma sp.		N	S	abamectin tech.	89.3	nw	8.5	20	84	48 h	mortality	LC50	0.530	2	21,23	EC, 2006 (Knauer, 2001c)
Gammarus sp.		N	S	abamectin tech.	89.3	nw	8.5	16	440	48 h	immobilisaton	LC50	6.20	2	21,23	EC, 2006 (Knauer, 2001h)
Gammarus sp.		Y	S	abamectin tech.	89.3	nw	8.5	10	100	48 h	immobilisaton	LC50	8.60	2	2,21,23	EC, 2006 (Knauer, 2001i)
Ostracoda		N	S	abamectin tech.	89.3	nw	8.2-8.3	20	110	48 h	immobilisaton	LC50	55	3	21,23,31	DAR, Knauer, 2001g
Rotifera																
Simocephalus sp.		Y	S	abamectin tech.	89.3	nw	8	20	100	48 h	mortality	LC50	0.300	2	2,21,23	EC, 2006 (Knauer, 2001b)
Thamnocephalus platyurus		N	S	abamectin tech.	89.3	rw	8.2	25		24 h	mortality	LC50	30	2	21,23	EC, 2006 (Knauer, 2001d)
Thamnocephalus platyurus		Y	S	abamectin tech.	89.3	rw	8.2	24 ± 1		24 h	mortality	LC50	2.80	2	2,21,23	EC, 2006 (Knauer, 2001e)
Insecta																
Aedes aegypti	4th instar larvae		S	avermectin B1	91%	tw		27 ± 2		5-7 d	mortality	LC50	4.80	2	18	Ali and Nayar, 1985
Aedes taeniorhynchus	4th instar larvae		S	avermectin B1	91%	tw		27 ± 2		5-7 d	mortality	LC50	0.70	2		Ali and Nayar, 1985
Anopheles albimanus	4th instar larvae		S	avermectin B1	91%	tw		27 ± 2		5-7 d	mortality	LC50	2.21	2		Ali and Nayar, 1985
Anopheles quadrimaculatus	4th instar larvae		S	avermectin B1	91%	tw		27 ± 2		5-7 d	mortality	LC50	6.60	2		Ali and Nayar, 1985
Chaoborus sp.		Y	S	abamectin tech.	89.3	nw	8.2-8.3	20	110	48 h	immobilisaton	LC50	190	2	2,21,23	EC, 2006 (Knauer, 2001f)
Chaoborus sp.		N	S	abamectin tech.	89.3	nw	8.2-8.3	20	110	48 h	immobilisaton	LC50	41	2	21,23	DAR, Knauer, 2001g
Chironomus crassicaudatus	4th instar larvae		S	avermectin B1	91%	tw		27 ± 2		5-7 d	mortality	LC50	1.63	2		Ali and Nayar, 1985
Cloeon sp.		N	S	abamectin tech.	89.3	nw	8.5	20.00	410	48 h	immobilisaton	LC50	2.90	2	21,23	EC, 2006 (Knauer, 2001g)
Culex nigipalpus	4th instar larvae		S	avermectin B1	91%	tw		27 ± 2		5-7 d	mortality	LC50	7.84	2		Ali and Nayar, 1985
Culex quinquefasciatus	4th instar larvae	N	S	avermectin B1		tw				72 h	mortality	LC50	120	3	17	Halliday et al, 1993
Culex quinquefasciatus	4th instar larvae	N	S	avermectin B1		tw				72 h	mortality	LC50	27	2	16	Halliday et al, 1993
Culex quinquefasciatus	2th instar larvae	N	S	avermectin B1						24 h	mortality	LC50	828	3	13,14,22	Murty, Jyothi and Jamil, 1987
Culex quinquefasciatus	3rd instar larvae	N	S	avermectin B1						24 h	mortality	LC50	2910	3	13,14,22	Murty, Jyothi and Jamil, 1987
Culex quinquefasciatus	4th instar larvae	N	S	avermectin B1						24 h	mortality	LC50	7970	3	5,13,14,22	Murty, Jyothi and Jamil, 1987
Culex quinquefasciatus	2th instar larvae	N	S	avermectin B1						24 h	mortality	LC50	1902	3	13,15,22	Murty, Jyothi and Jamil, 1987
Culex quinquefasciatus	3rd instar larvae	N	S	avermectin B1						24 h	mortality	LC50	4943	3	5,13,15,22	Murty, Jyothi and Jamil, 1987
Culex quinquefasciatus	4th instar larvae	N	S	avermectin B1						24 h	mortality	LC50	11020	3	5,13,15,22	Murty, Jyothi and Jamil, 1987
Culex quinquefasciatus	4th instar larvae		S	avermectin B1	91%	tw		27 ± 2		5-7 d	mortality	LC50	7.72	2		Ali and Nayar, 1985
Culex salinarius	4th instar larvae		S	avermectin B1	91%	tw		27 ± 2		5-7 d	mortality	LC50	7.59	2		Ali and Nayar, 1985

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 [µg/L]	Ri	Notes	Reference
Glyptotendipes paripes	4th instar larvae		S	avermectin B1	91%	tw		27 ± 2		5-7 d	mortality	LC50	1.52	2		Ali and Nayar, 1985
Wyeomyia mitchelli	4th instar larvae		S	avermectin B1	91%	tw		27 ± 2		5-7 d	mortality	LC50	2.25	2		Ali and Nayar, 1985
Mollusca																Ali and Nayar, 1985
Lymnaea stagnalis		Y	S	abamectin tech.	89.3	nw	8	20	100	48 h	immobilisaton	LC50	55	2	2,21,24	EC, 2006 (Knauer, 2001j)
Pisces																
Cyprinus carpio	length 53 ± 0.55 mm	N	F	abamectin tech.	97	dw	7.8-7.9	21 ± 1	320	96 h	mortality	LC50	42	2	25	EC, 2006 (Douglas, Pell, 1985)
Ictalurus punctatus	length 36 ± 0.18 mm	N	S	abamectin tech.	91	rw	7.1-7.6	21-23	40-45	96 h	mortality	LC50	24	2	9,23	EC, 2006 (McAllister, Bowman, Cohle, 1985
Lepomis macrochirus	length 23-36 mm	N	S	abamectin tech.	91.43	rw	6.7-7.5	21-22	42	96 h	mortality	LC50	9.60	3	8,23	EC, 2006 (LeBlanc, Wilson, 1981)
Lepomis macrochirus	length 23-36 mm	N	F	avermectin B1a	>99	nw	7.8-8.1	21-22	255	96 h	mortality	LC50	7.20	2	23	EC, 2006 (Forbis, 1983)
Onchorhynchus mykiss	length 29-38 mm	N	S	abamectin tech.	91.43	rw	6.9-7.3	12 ± 1	40	96 h	mortality	LC50	3.60	2	23	EC, 2006 (LeBlanc, Sousa, 1981
Onchorhynchus mykiss	length 52 ± 2 mm	N	F	abamectin tech.	86.2	tw	7.7-8.1	13.5	202	96 h	mortality	LC50	8.70	2	9,25	EC, 2006 (Peither, 2003
Onchorhynchus mykiss	length 48-62 mm	Y	F	formulation	2.02	nw	7	12 ± 1	31-40	96 h	mortality	LC50	2.60	3	10,12,25,27,28	EC, 2006 (Dionne, 1997
Onchorhynchus mykiss		N	F	formulation	1.8	tw	7.4-8.1	15	350	96 h	mortality	LC50	2.30	3	10,12,25,29	EC, 2006 (Douglas, Pell, 1986
Onchorhynchus mykiss				abamectin								LC50	3.20	4		Wislocki, Grosso and Dybas, 1989
Pimephales promelas	length 3.6 ± 0.2 mm	Y	F	abamectin tech.	86.2	tw	7.8-7.9	23.5	204	96 h	mortality	LC50	14.7	2	2,9,25	EC, 2006 (Bätscher, 2003a)

NOTES

1 Chinese National Environmental Protection Agency Guidelines 201
2 based on mean measured concentrations
3 based on actual initial concentrations
4 equivalent to >82 mg formulation/L
5 nominal concentration is above water solubility limit of 1.21 mg/L
6 measured concentrations above water solubility limit of 1.21 mg/L but no flocculation occurred at any concentration
7 equivalent to 29 mg formulation/L
8 test solutions were cloudy in several test vessels
9 corrected for purity in DAR
10 equivalent to 130 µg product/L
11 7.6 µg/L according to E-tox base but 7.6 mg/L according to Aquire
12 formulation containing 1.9% as
13 ratio B1a : B1b = 85 : 15
14 lab reared larvae 2nd instars most susceptible
15 field collected larvae, 2nd instars most susceptible
16 susceptible strain
21 OECD 202
17 resistant strain
18 ratio B1a : B1b = 85 : 15
19 spiked sediment, concentrations measured at start and end of experiment
20 above solubility in water of 1210 µg/L
22 LC50 unreasonable high
23 US EPA 1975
24 US EPA FIFRA 72-2
25 OECD 203
26 ASTM 1982
27 FIFRA 71-1
28 EC L383A-C.1
29 PSPS working doc D2
30 EC L383A-C.1
31 highest immobilisation rate was 45% and showed an irregular pattern
32 exposure duration too long; no exponential growth

Table A2.2. Acute toxicity of abamectin to marine organisms.

Species	Species properties	A	Test type	Test compound	Purity [%]	Test water	pH	T [°C]	Salinity [‰]	Exp. time	Criterion	Test endpoint	Value [µg/L]	Ri	Notes	Reference
Crustacea																
Callinectes sapidus		N	S	abamectin tech.	90.5	nw	7.8	22	18	96 h	mortality	LC50	153	2	8	EC, 2006 (Ward, 1983c)
Mysidopsis bahia		N	S	abamectin tech.	91.0	am	8.0-8.5	22	22	96 h	mortality	LC50	0.210	2	6,7	EC, 2006 (Forbis and Burgess, 1985)
Mysidopsis bahia		Y	F	3H-abamectin	>99	nw	7.7	25 ± 1	30	96 h	mortality	LC50	0.022	2	2,3,6,7	EC, 2006 (Surprenant, 1988a)
Mysidopsis bahia	< 1 d old	Y	F	3H-abamectin	>99	nw	7.9	25 ± 1	31	96 h	mortality	LC50	0.020	2	2,4,6,7	EC, 2006 (Surprenant, 1988b)
Penaeus duorarum		N	S	abamectin tech.	90.5	nw	8.2	22	28	96 h	mortality	LC50	1.600	2	8	EC, 2006 (Ward, 1983b)
Mollusca																
Crassostrea virginica	embryos	N	S	abamectin tech.	90.5	nw	8	21 ± 1	24	48 h	mortality	LC50	430	2	8	EC, 2006 (Ward, 1983a)
Pisces																
Cyprynodon variegatus	length 12 ± 1 mm	N	R	abamectin tech.	91.0	nw	8.1-8.4	19-21	19-20	96 h	mortality	LC50	15	2	1,5	EC, 2006 (Ward, 1985)

NOTES
1 ASTM 1982
2 based on mean measured concentrations
3 ratio B1a: B1b 7.95 : 1
4 ratio B1a: B1b 11.8 : 1
5 results reported in nominal concentrations a.i.
6 EPA 1975
7 APHA 1980
8 BMRL 1982

Table A2.3. Chronic toxicity of abamectin 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 [µg/L]	Ri	Notes	Reference
Algae																
Pseudokirchneriella subcapitata	1 x 10^4 cells/mL	Y	S	formulation	1.9	am	7.6-9.9	22.5-24.0		72 h	growth	NOEC	>1210	2	2,4,5,6	EC, 2006 (Sutherland, Kendall, Krueger, 2000)
Pseudokirchneriella subcapitata	1 x 10^4 cells/mL	Y	S	formulation	1.9	am	7.6-9.9	22.5-24.0		72 h	biomass	NOEC	> 1210	2	2,4,5,6	EC, 2006 (Sutherland, Kendall, Krueger, 2000)
Crustacea																
Daphnia magna		Y	F	5-3H-avermectin B1a	91.43	rw	8	20	160	21 d	mortality	NOEC	0.03	2	2,7	EC, 2006 (Paradice, 1983)
Daphnia magna		N	R	abamectin tech.	89.3	am	8	20	200	21 d	reproduction	NOEC	0.01	2	7,8	EC, 2006 (Pfeifle, 2001)
Pisces																
Onchorhynchus mykiss	eggs	Y	F	abamectin tech.	91	nw	8.0 ± 0.5	12	225-275	72 d	weight	NOEC	0.52	2	2,3,4	EC, 2006 (McAllister, 1986)
Onchorhynchus mykiss	eggs	Y	F	abamectin tech.	91	nw	8.0 ± 0.5	12	225-275	72 d	hatching	NOEC	2.20	2	2,3,4	EC, 2006 (McAllister, 1986)
Onchorhynchus mykiss	eggs	Y	F	abamectin tech.	91	nw	8.0 ± 0.5	12	225-275	72 d	mortality	NOEC	0.96	2	2,3,4	EC, 2006 (McAllister, 1986)
Onchorhynchus mykiss	eggs	Y	F	abamectin tech.	91	nw	8.0 ± 0.5	12	225-275	72 d	length	NOEC	0.96	2	2,3,4	EC, 2006 (McAllister, 1986)
Cyprinus carpio		Y	F	abamectin tech.	89.3	dw	8.2-8.5	22 ±2	180	28 d	mortality	NOEC	6.10	2	2,9,10	EC, 2006 (Rufli, 2000)
Cyprinus carpio		Y	F	abamectin tech.	89.3	dw	8.2-8.5	22 ±2	180	28 d	weight	NOEC	6.10	2	2,9,10	EC, 2006 (Rufli, 2000)
Cyprinus carpio		Y	F	abamectin tech.	89.3	dw	8.2-8.5	22 ±2	180	28 d	behaviour	NOEC	6.10	2	2,9,10	EC, 2006 (Rufli, 2000)

NOTES

1 according to current guidelines
2 based on mean measured concentrations
3 ASTM 1983
4 US EPA 1972
5 OECD 201
6 EC L383 A, C.3
7 OECD 211
8 US EPA FIFRA 72-4
9 OECD 204, 1984
10 draft OECD 215, 2000

Table A2.4. Chronic toxicity of abamectin to marine organisms.

Species	Species properties	A	Test type	Test compound	Purity [%]	Test water	pH	T [°C]	Salinity [‰]	Exp. time	Criterion	Test endpoint	Value [µg/L]	Ri	Notes	Reference
Crustacae																
Mysidopsis bahia	<24 h	Y	F	3H-abamectin	>99	nw	7.8	25	30	28 d	survival	NOEC	0.0035	1	1,2,3,4	EC, 2006 (Surprenant, 1988c)
Mysidopsis bahia	<24 h	Y	F	3H-abamectin	>99	nw	7.8	25	30	28 d	weight	NOEC	0.0035	1	1,2,3,4	EC, 2006 (Surprenant, 1988c)
Mysidopsis bahia	<24 h	Y	F	3H-abamectin	>99	nw	7.8	25	30	28 d	reproduction	NOEC	0.0035	1	1,2,3,4	EC, 2006 (Surprenant, 1988c)

NOTES

1 EPA 1975
2 based on mean measured concentrations
3 ratio B1a:B1b 13:1
4 APHA 1980

Appendix 3. Description of mesocosm studies

Study 1

Species/Population/Community	phytoplankton, zooplankton, emerging insects
Test Method	outdoor microcosms
System properties	Depth 1.5 m, diameter 3 m, volume 10 m^3
Formulation	Vertimec 0.18 EC
Analyzed	Y
Exposure regime	single application
Experimental time	until 91 days after application
Criterion	1-49 d after treatment NOEC
Test endpoint	zooplankton populations and zooplankton community and phytoplankton (PRC)
Value [µg/L]	0.066
Ri	2
Reference	EC, 2006 (Rufli, 1999)

Evaluation of the underlying mesocosm study is performed based on the summaries of Rufli, 1999 in the DAR.

Test system. 21 microcosms (depth 1.5 m, diameter 3 m, volume 10 m^3, 10 cm sandy loam on 5 cm clay) were placed Stein, Aargau, CH in spring 1998.
Macrophytes (*Myriophyllum verticulatum* and *Potamogeton crispus*) were planted. Algae, zooplankton and other organisms were introduced during three months before application from a supply pond. Macroinvertebrates further entered the cosm by aerial colonization.
Application took place on June 30. Cosms were treated once at 0.066, 0.20, 0.62, 1.8, 5.6 and 17 µg a.s./L, 3 replicates. Half-live 9-10 days. Circulation of water 14 days after application.
Analytical sampling.
Water was sampled before application and 2 h, 1, 3, 6, 13, 21, 28, 35 and 49 d after treatment. LOQ 0.1 µg/L.
Effect sampling. Phytoplankton and zooplankton were assessed on day 1, 3, 6, 13, 21, 28, 35, 49, 63, 77 and 91 after application. Zooplankton species were identified and counted. Phytoplankton algal species were identified, biomass and chlorophyll *a* were determined. Emerging insects were sampled 6, 13, 35, 49, 63, 77 and 91 days after application.
Statistical analysis
Mutivariate (PRC) and univariate statistics (Dunnett's test) were applied. Effects on dominant groups of zooplankton and emergent insects were assessed for two aggregated time intervals (day 1-49 and day 63-91)
RESULTS
Chemical analysis.
Measured concentrations 2 h post application were < LOQ for the lowest test concentration, 99 and 84 % of nominal at 0.2 and 0.62 µg/L and 54 and 55% of nominal in the 5.6 and 17 µg/L treatment, gradually decreasing to < LOQ 35 d after treatment.
Biological observations.
Clear significant increases in phytoplankton (PRC) were found in the 1.8 µg/L treatment and higher. In the lower treatments effects were found on isolated sampling dates. The effects is supposed to be an indirect effect, due to decreases of zooplankton.
For zooplankton a significant effect (decrease) is found in the 0.2 µg/L treatment on one sampling date, in the higher dosages effects were found on a number of consecutive sampling dates. For individual dominant groups clear significant effects are found in the 1.8 µg/L treatment and higher. At the lowest concentration, in the first time period (1-49 d) a significant lowered abundance of *Keratella quadrata.* Since this effect is not treatment related it is not assessed relevant. The same can be said for an increase of *S. vetulus.*
For emergent insects significant effects were found at concentrations of 0.62 µg/L and higher.

Evaluation of the scientific reliability of the field study

Criteria for a suitable (semi)field study

1. Does the test system represent a realistic freshwater community? Yes, zooplankton, phytoplankton, periphyton, macroinvertebrates were present. No fish. Macrophytes were planted.
2. Is the description of the experimental set-up adequate and unambiguous? Yes.
3. Is the exposure regime adequately described? Is the exposure regime adequate to derive a MAC or an AA value? The exposure regime is adequately described. The Evaluating Institute considered the use of nominal values to express effect concentrations acceptable, since at lower levels measured concentrations were > 80% of nominal. Since the compound is applied only once, and the half-live is 9-10 days, the study cannot be used to derive an AA (MPC) value.
4. Are the investigated endpoints sensitive and in accordance with the working mechanism of the compound? Yes. In laboratory studies, *Daphnia* and insects were most susceptible to abamectin, as was also the case in the underlying cosm-experiment.
5. Is it possible to evaluate the observed effects statistically? No, but the statistics described are considered to be sufficient to evaluate the study results adequately. The only draw-back is that the univariate analyses is performed for two post application time periods only.

This result in an overall assessment of the study reliability, due impossibility to analyse the results per sampling data, -> Ri 2.

Evaluation of the results of the study

In the dose of 0.20 µg/L significant treatment related effects are found for Cyclopoida, zooplankton community and the phytoplankton community.

Therefore the NOEC for acute effects is set at 0.066 µg/L, and this value is considered to be useful to derive a MAC value.

Further discussion

After two weeks the cosms were interconnected, enhancing recolonisation and this will enhance recovery. Since in this study only acute effects are deemed relevant, this phenomena has no influence on the acute endpoint.

Study 2

Species/Population/Community	phytoplankton, zooplankton, macro-invertebrates, emerging insects
Test Method	outdoor microcosms
System properties	depth 1.5 m, diameter 3 m, volume 10 m^3 Sediment loam, 15 cm.
Formulation	Vertimec 0.18 EC
Analyzed	Y
Exposure regime	3 weekly applications
Experimental time	until 17-18 weeks after last application
Criterion	effects after third treatment NOEC
Test endpoint	phytoplankton and zooplankton populations and zooplankton community (PRC)
Value [µg/L]	3 x 0.015 mean actual concentration 1 d after last application 0.048 µg/L
Ri	2
Reference	Ec, 2006 (Knauer, 2002)

Evaluation of the underlying microcosm study is performed based on the summaries of Knauer, 2002 in the DAR

Test system. 21 microcosms (depth 1.5 m, diameter 3 m, volume 10 m^3, 15 cm loam) were placed Stein, Aargau, CH in spring 1996.
Macrophytes (*Myriophyllum verticulatum* and *Potamogeton crispus*) were planted in 1998, but microcosms were dominated by naturally entered *Elodea canadensis*. Algae, zooplankton and other organisms were introduced during three months before application from a supply pond.
Macroinvertebrates further entered the cosm by aerial colonization.
Application took place on May 9, 16 and 23, 2000. Cosms were treated at 0.005, 0.015, 0.0.045, 0.135, 0.405 and 1.22 µg as/L, 3 replicates. Circulation of water 14 days after application.
Analytical sampling.
Water was sampled before application and 6 h, 1, 3 and 7 days after each application and on day 14, 21, 35, 49, 65 and 77 days after the third application. LOQ 0.1 µg/L for the three highest concentrations, and 1 ng/L for the three lowest concentrations.
Effect sampling. Phytoplankton and zooplankton were assessed on day 1 and 3 after each application and on day 7, 21, 35, 49, 65, 77, 91, 105 and 119 after the third application. Emergent insects were assessed 7 days after each application and 21, 35, 49, 65, 77, 91, 105 and 119 days after third application. Macroinvertebrates were assessed 2 days after each application and 15, 28, 43, 56, 71, 98 and 126 days after last application. Zooplankton species were identified and counted. Phytoplankton algal species were identified, biomass and chlorophyll *a* were determined.
Statistical analysis
Multivariate (PRC) and univariate statistics (Dunnett's test) were applied. One replicate of the 3 x 0.015 µg/L treatment was left out of analysis because it received only two applications.
RESULTS
Chemical analysis.
Measured concentrations 6 h post application were very variable in the lowest three application levels (7 – 257% of nominal). From the results a DT_{50} value of 4.9 days was calculated.
Biological observations.
Clear significant increases in phytoplankton (PRC) were found in the after the third treatment with 0.405 µg/L. In the 0.015 µg/L treatment a decrease of phytoplankton was found on day 14-63. In the 0.045 µg/L treatment an increase was found on a few individual sampling dates, but at 0.135 µg/L a decrease was found. The effect is supposed to be an indirect effect, due to decreases of zooplankton.
For zooplankton a decrease is found in all concentrations, in the lowest concentrations on one sampling date (21 d after third treatment, significant in the lowest treatment only, in the next treatment an increase is found), in the higher dosages effects were found on a number of consecutive sampling dates.
According to the author and the evaluator the NOEC for community effects is 3 x 0.015 µg a.s./L. For individual species Cyclopoida and *Chyrodorus sphaericus* the lowest NOEC is found (3 x 0.015 µg a.s./L). The same NOEC was found for the Crustacea-Copepoda.

For macroinvertebrates community the NOEC is 3 x 0.015 µg a.s./L. For emergence the NOEC community is 3 x 0.045 µg a.s./L.

Evaluation of the scientific reliability of the field study

Criteria for a suitable (semi)field study

1. Does the test system represent a realistic freshwater community? Yes, zooplankton, phytoplankton, periphyton, benthic macroinvertebrates were present. Macrophytes *Myriophyllum verticulatum* and *Potamogeton crispus* were planted, ponds were however demented by natural occurring *Elodea canadensis*. No fish present.
2. Is the description of the experimental set-up adequate and unambiguous? Yes.
3. Is the exposure regime adequately described? Is the exposure regime adequate to derive a MAC or an AA value? The exposure regime is adequately described. Cosms were treated three times with a 7 day interval with 0.005, 0.015, 0.0.045, 0.135, 0.405 and 1.22 µg as/L, 3 replicates. The median dissipation time after the third application was estimated to be 4.3-5.8 days, Therefore the study cannot by used for derivation of an AA value. The study could be useful underpinning a MAC value based on the measured concentration after the third application. There are, however, indications that there is a cumulation of effects (e.g. effects are only found after the third treatment), although concentrations are not accumulative. Therefore, using the NOEC after repeated applications for the MAC represents a worst case.
4. Are the investigated endpoints sensitive and in accordance with the working mechanism of the compound? Yes. In laboratory studies, *Daphnia* and insects were most susceptible to abamectin, as was also the case in the underlying cosm-experiment.
5. Is it possible to evaluate the observed effects statistically? No, but the statistics described are considered to be sufficient to evaluate the study results adequately.

This results in an overall assessment of the study reliability, due impossibility to analyze the results per sampling data, -> Ri 2.

Evaluation of the results of the study

At 3 x 0.015 µg/L a significant decrease of the phytoplankton community was found. However, this effect is not treatment related, and assumed to be an indirect effect. Therefore it is not used to assign the NOEC. Some effects were found for zooplankton and Cyclopoida also, but these effects were not treatment related as well. At 3 x 0.045 µg/L clear treatment related effects are found and therefore the next lower concentration of 3 x 0.015 is the NOEC of the microcosm study. The mean actual concentration (3 cosms) is 0.016 µg/L at day 15 (1 day after third treatment).

rivm

Appendix 4. Detailed sediment toxicity data

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 [$\mu g/kg_{dw}$]	Ri	Notes	Reference
Insecta																
Chironomus riparius	1st instar larvae	Y	S	12C-avermectin B1a	92.5	am	8	20	240	28 d	emergence	NOEC	3.30	2	1,2,4,6	EC, 2006 (Grade, 2002)
Chironomus riparius	1st instar larvae	Y	S	12C-avermectin B1a	92.5	am	8	20	240	28 d	development	NOEC	10.00	2	1,2,4,6	EC, 2006 (Grade, 2002)

NOTES

1 OECD proposal 1998 and BBA proposal 1995
2 based on nominal concentrations in sediment
3 water spiked; based on nominal initial concentrations in overlying water
4 sediment spiked
5 purity too low
6 5.5% peat

Appendix 5. References used in the appendices

EC, 2006. Abamectin, Draft Assessment Report. Rapporteur Member State: The Netherlands. Public version, June 2006.

Ali, A and Nayar, J. K. Activity of an avermectin insecticide Abamectin (MK-936), against mosquitoes and chironomid midges in the laboratory. Journal of the American mosquito control association 1(3), 384-386. 85.

Halliday, W. R. and Georghiou, G. P. Cross-Resistance and Dominance Relationships of Pyrethroids in a Permethrin-Selected Strain of Culex quinquefasciatus (Diptera: Culicidae). Journal of Economic Entomology 78, 1227-1232. 85.

Ma, J., Zheng, R., Xu, L., and Wang, S. Differential sensitivity of two green algae, scenedesmus obliqnus and chlorella pyrenoidosa, to 12 pesticides. Ecotoxicology and Environmental Safety 52(1), 57-61. 2002.

Murty, U. S., Jyothi, K N, and Jamil, K. Effect of avermectin B1 (L-676) a metabolite from Streptomyces avermilitis on immature Culex quinquefasciatus. Indian Journal of Medical Research 85(May), 539-541. 87.

RIVM

National Institute
for Public Health
and the Environment

P.O. Box 1
3720 BA Bilthoven
The Netherlands
www.rivm.com