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SCIENTIFIC COMMITTEE ON PLANTS **SCP/ATRAZINE/002-Final**

OPINION OF THE SCIENTIFIC COMMITTEE ON PLANTS ON SPECIFIC QUESTIONS FROM THE COMMISSION CONCERNING THE EVALUATION OF ATRAZINE IN THE CONTEXT OF COUNCIL DIRECTIVE 91/414/EEC

(Opinion adopted by the Scientific Committee on Plants on 30/01/2003)

A. TITLE

OPINION OF THE SCIENTIFIC COMMITTEE ON PLANTS ON SPECIFIC QUESTIONS FROM THE COMMISSION CONCERNING THE EVALUATION OF ATRAZINE IN THE CONTEXT OF COUNCIL DIRECTIVE 91/414/EEC
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B. TERMS OF REFERENCE

Atrazine is a herbicide among the existing active substances selected in the first review list published in Commission regulation 3600/92. On the basis of the evaluation report established by the United Kingdom as Rapporteur Member State (RMS), the substance has been peer reviewed with Member State experts and consequently discussed with the 15 Member States in the working group "Plant Protection Products - Evaluation" of the Standing Committee on Plant Health.
The main problem identified during the review relates to the leaching potential of the active substances and their breakdown products. The Rapporteur has evaluated extensive modelling data and also monitoring data from several Member States and has identified use conditions, which are unlikely to lead to a contamination of groundwater. However, a consultation of the Scientific Committee on Plants appears necessary to have an additional, independent opinion on the following questions:

QUESTION 1: Can the Committee comment on the approach taken by the Rapporteur for the calculation of predicted environmental concentrations (PEC[1]) in groundwater?

QUESTION 2: Does the Committee agree that the available monitoring data show that in large areas, application of atrazine under the intended conditions (i.e. max. 0.75 kg a.s./ha in northern Member States and max. 1.0 kg a.s./ha in southern Member States on maize and sorghum in spring) will not result in concentrations of the active substance or its breakdown products in excess to 0.1 μg/L in groundwater ?

C. OPINION OF THE COMMITTEE

Opinion on question 1:
The Rapporteur reported a number of studies for the calculation of PEC in groundwater but considered the first and higher tier FOCUS[2] modelling approaches reported on p. 59-77 of Addendum 4 to Annex B of February 2001 as most definitive. Therefore the Committee restricts its comments to these approaches.

The results of calculations of PEC in groundwater are very sensitive to the input parameters that describe the sorption and transformation of atrazine and its metabolites in soil. Therefore the Committee's comments consist of an assessment of these input parameters.

[1] PEC: Predicted Environmental Concentration

[2] FOCUS: Forum for international Co-ordination of pesticide fate models and their USe

With respect to the first tier approach, the Committee accepts the quoted sorption and transformation parameters for the metabolites de-ethylatrazine, de-isopropylatrazine and hydroxyatrazine and also the sorption parameters for atrazine. The half-lives used for atrazine were based on the results of field studies and their justification was reported in insufficient detail. Based on the limited information provided, the Committee considers these half-lives not acceptable.

In the higher tier modelling approach increased sorption coefficients were used for atrazine and its metabolites to take account of the phenomenon of increased sorption with time. The Committee does not accept these increased sorption coefficients because the measurement procedure was inappropriate. In this modelling approach also shorter half-lives were used for atrazine and its metabolites to describe enhanced transformation resulting from repeated applications. The shorter half-lives were assumed to apply to all FOCUS scenarios. The Committee accepts these shorter half-lives but only for the FOCUS scenarios with pH above 6 because no evidence of enhanced transformation rates for soils with pH below 6 was presented.

As a result of the above considerations, the Committee does not accept the reported first and higher tier calculations of the environmental concentrations (PEC) of atrazine and its metabolites in groundwater.

<u>Opinion on question 2:</u>
The Committee considered available evidence from lysimeter studies (scale of 1 m^2), field monitoring studies (scale of ha) and of monitoring studies at regional scale. Two of the three soils studied in lysimeter studies resulted in concentrations of atrazine or de-ethylatrazine in lysimeter leachate exceeding 0.1 μg/L indicating the potential of atrazine to contaminate groundwater. European field monitoring studies at four sites with cropped soils gave variable results: concentrations of atrazine and its de-ethylatrazine and de-isopropyl atrazine were sometimes above 0.1 μg/L and sometimes below 0.1 μg/L. Monitoring studies in wells at a regional scale in France, Greece, Spain and Portugal showed only incidental exceedance of the 0.1 μg/L concentration for atrazine and de-ethylatrazine. However, the reports of these studies justified the sampling strategy insufficiently. The Committee considers the resulting interpretation problems so serious that they can even not be solved by considering the reduction in use rates proposed by the notifier. Therefore it is the Committee's opinion that available monitoring data does not demonstrate that concentrations of the active substance or its breakdown products will not exceed 0.1μg/l in groundwater and the Committee expects that for soils with pH above 6 concentrations of atrazine and its breakdown products will not exceed 0.1μg/l.

A. TITLE

REPORT OF THE SCIENTIFIC COMMITTEE ON PLANTS ON SPECIFIC QUESTIONS FROM THE COMMISSION CONCERNING THE EVALUATION OF ATRAZINE IN THE CONTEXT OF COUNCIL DIRECTIVE 91/414/EEC

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C. SOURCE DOCUMENTS MADE AVAILABLE TO THE COMMITTEE

1. SCP-ATRA 001: Terms of references.
2. SCP-ATRA 003: Monograph (DAR) to the Report and Proposed Decision of the United Kingdom made to the European Commission under Article 7(1) of Regulation 3600/92, Volume 1, October 1996.
3. SCP-ATRA 004: Volume 2, Annex A, List of tests and studies, October 1996.
4. SCP-ATRA 005: Volume 2, Annex A, List of tests and studies, April 1999.
5. SCP-ATRA 006: Volume 3, Annex B1 to 9, Summary, Scientific evaluation and assessment, October 1996.
6. SCP-ATRA 007: Addendum to monograph, Volume 3, Annex B, Summary, Scientific evaluation and assessment, February 2000.
7. SCP-ATRA 008: Addendum 2 to monograph, Volume 3, Annex B, occurrence in groundwater, February 2001.
8. SCP-ATRA 009: Addendum 3 to monograph, Volume 3, Annex B, occurrence in groundwater, March 2001.
9. SCP-ATRA 010: Addendum 4 to monograph, Volume 3, Annex B September 2001.
10. SCP-ATRA 011: Exposure of ground water to atrazine in agricultural areas of Portugal. Batista, S., E. Silva & M.J. Cerejeira, 2002. Exposure of groundwater to atrazine in agricultural areas of Portugal. Report, ISA, Lisbon, 14 pp.
11. SCP-ATRA 012: Evaluation table Doc. 5041/VI/98 rev. 10 (12.10.01).
12. SCP-ATRA 013: Papastergiou, A & E Papadopoulou-Mourkidou, 2001. Occurence and spatial and temporal distribution of pesticide residues in groundwater of major corn-growing areas of Greece (1996-1997). Environ. Sci. Technol. 35: 63-69.
13. SCP-ATRA 014: Report Syngenta, Basel, Egli, H & H-P Buser, 2002. Statement: EU review of atrazine and simazine -Proposal of safe use areas with regard to residues in ground- and surface water, 17 pp.
14. SCP-ATRA 015: Report Syngenta, Basel: Egli, H & H-P Buser, 2002. Position paper: EU review of atrazine and simazine - Comments to questions referred to SCP concerning the assessment of the risk of atrazine and simazine to groundwater, 16 pp.

I. Question 1:

Can the Committee comment on the approach taken by the Rapporteur for the calculation of predicted environmental concentrations (PEC) in groundwater?

Opinion on question 1:

The Rapporteur reported a number of studies for the calculation of PEC in groundwater but considered the first and higher tier FOCUS modelling approaches reported on p. 59-77 of Addendum 4 to Annex B of February 2001 as most definitive. Therefore the Committee restricts its comments to these approaches.

The results of calculations of PEC in groundwater are very sensitive to the input parameters that describe the sorption and transformation of atrazine and its metabolites in soil. Therefore the Committee's comments consist of an assessment of these input parameters.

With respect to the first tier approach, the Committee accepts the sorption and transformation parameters for the metabolites de-ethylatrazine, de-isopropylatrazine and hydroxyatrazine and also the sorption parameters for atrazine. The half-lives used for atrazine were based on results of field studies and their justification was reported in insufficient detail. Based on the limited information provided, the Committee considers these half-lives not acceptable.

In the higher tier modelling approach increased sorption coefficients were used for atrazine and its metabolites to take account of the phenomenon of increased sorption with time. The Committee does not accept these increased sorption coefficients because the measurement procedure was inappropriate. In this modelling approach also shorter half-lives were used for atrazine and its metabolites to describe enhanced transformation resulting from repeated applications. The shorter half-lives were assumed to apply to all FOCUS scenarios. The Committee accepts these shorter half-lives but only for the FOCUS scenarios with pH above 6 because no evidence of enhanced transformation rates for soils with pH below 6 was presented.

As a result of the above considerations, the Committee does not accept the reported first and higher tier calculations of the environmental concentrations (PEC) in groundwater.

Scientific background on which the opinion is based

I.1. Introduction

Results of calculations of $PEC_{groundwater}$ depend strongly on the model input parameters that describe sorption and transformation rate of the substances considered. Therefore the Committee analyses firstly the available information on these parameters before considering the different calculation approaches.

I. 2. Transformation

I.2.1 Soil metabolism in topsoils

Laboratory studies showed that the transformation rate of atrazine may be enhanced by repeated applications for soils with pH values above 6. If this enhanced transformation occurs, $^{14}CO_2$ (formed from triazine-ring labelled atrazine) is the main transformation product. Typical percentages CO_2 range from 50 to 80%. If no enhanced transformation occurs, the percentage CO_2 is usually less than 5% and atrazine transforms into soil bound residues and three metabolites: de-ethylatrazine (further called "DEA"), de-isopropylatrazine (further called "DIA") and hydroxyatrazine (further called "HA"). When no measurable amounts of atrazine are left in soil, the percentage soil bound residues ranges between 40 and 60%. In studies with a few soils, the maximum percentages DEA, DIA and HA were 22, 7 and 42%, respectively.

I.2.2 Transformation rates in topsoils

Of the laboratory studies presented in the monograph only two were with soils that were relevant to calculate the half-life of atrazine at reference conditions as required by FOCUS (2000) for use in FOCUS groundwater scenarios (Les Barges loam soil and a Californian loam soil). The Committee calculated from these studies half-lives of 47 and 177 days at reference conditions.

Addendum 4 to Annex B (dated September 2001) reports that the notifier compiled studies on atrazine transformation rate in soil and calculated from these the half-lives at reference conditions. The number of soils was 20 and a median half-life of 30 days was found (the range was 6 to 106 days). These soils had received at most one atrazine treatment before the start of the studies. The Notifier also compiled studies with 51 soils that had received at least 3 previous treatments. The median half-life of atrazine at reference conditions was 13 days (the range was 3 to 55 days). The Committee cannot check the details of this compilation because no systematic list of these 71 half-lives was provided. A further analysis reported in this Addendum showed that this enhanced transformation occurs only in soils with a pH above 6 (as indicated also in Section 2.1). The Committee agrees with the Rapporteur that there is clear evidence of enhanced transformation of atrazine in soil if the pH is above 6.

Laboratory and field studies showed that atrazine can be degraded photochemically at the soil surface: half-lives ranged from 3 h to 45 days.

The monograph describes results of a large number of experiments on field persistence but the Committee could not calculate half-lives of atrazine transformation in soil from these experiments because the results were not described in sufficient detail.

The monograph reports six studies on the transformation rate of DEA in top soils. One was carried out with a soil from a field with a history of atrazine use. The Committee cannot derive a half-life at reference conditions from this study because its moisture content is not clear. For the five remaining studies the soil texture was not reported and the studies were conducted at 25^{o}C and a moisture content corresponding to a suction of 33 kPa. The Committee calculated the correction factor between 10 and 33 kPa for all soil textures using Table 5.2 of FOCUS (2000); the factors ranged from 0.68 to 0.93 and the average was 0.85. The Committee used the average of 0.85 for all studies. To convert from 25 to 20 ^{o}C, FOCUS (2000) recommends a multiplication factor of 1.48. So the total correction factor becomes 0.85 times 1.48 which equals 1.26. Thus half-lives of

DEA at reference conditions of 24, 52, 65, 65 and 68 days were calculated which gives an average of 55 days.

The atrazine monograph reports only one study on the transformation rate of DIA. This was carried out with a soil from a field with a history of atrazine use. The Committee cannot derive a half-life at reference conditions from this study because its moisture content is not clear. The simazine monograph also reports one measurement of the transformation rate of DIA (which is the same molecule as de-ethylsimazine). The half-life at 25°C and at a matric suction of 330 hPa was 32 days. This corresponds with a half-life of 47 days at 20°C (using a Q_{10}[3] of 2.2 as recommended by FOCUS, 2000, p. 92). The half-life at the reference condition could not be calculated back to the reference matric suction of 100 hPa because the soil texture was not reported. The correction factor (as derived from FOCUS, 2000, p. 90) ranges from 0.68 to 0.93 depending on the selected soil texture so the estimated half-life at reference conditions ranges from 32 to 44 days.

On p. 61 of Addendum 4 to Annex B, the Rapporteur briefly mentions three half-lives of DIA in soil at reference conditions (24, 27 and 48 days). The studies from which these were derived were not summarized in the monograph.

The monograph reports five studies on the transformation rate of HA in top soil. These studies were from the same literature reference as DEA so again the correction factor of 1.26 was used. This resulted in half-lives of HA at reference conditions of 40, 43, 139, 199 and 208 days which gives an average of 126 days.

I.3. Sorption

The monograph describes results of adsorption studies with atrazine, DEA, DIA and HA from seven literature references. Four of these report Freundlich exponents [4]exceeding 1.0 for at least 50% of the sorption isotherms. This is a strong indication of systematic errors because it is unlikely that Freundlich exponents of pesticide-soil sorption isotherms exceed 1.0. Therefore results from these references are not considered further. Part of the remaining studies were based on measurements at only one concentration level. Because this is a weak basis, these data are also not used by the Committee. After this selection, data from two references were left for atrazine ("Brouwer et al., 1990" and "Dousset et al., 1994"). The Committee had to correct the K_{OC}[5] values from Brouwer et al. (1990) because the Rapporteur used K_{OC} values evaluated at a concentration in the liquid phase of 1000 mg/L which is not defensible. This resulted in the following selected K_{OC} values for atrazine: 76, 80 , 87, 109, 111, 112 and 176 L/kg which gives an average K_{OC} of 107 L/kg. The average Freundlich exponent of these studies was 0.86. Brouwer et al. (1990) plotted the results of about 70 adsorption studies with atrazine.

[3] Q10: factor describing the increase of the transformation rate of pesticides in soil resulting from a temperature increase of 10°C Celsius

[4] The Freundlich exponent describes the curvature of the sorption isotherm. A value of 1.0 implies a linear isotherm and a value below 1.0 implies a continuously decreasing slope of the sorption isotherm.

[5] Koc : Organic carbon adsorption coefficient

The Committee checked that all seven selected K_{OC} values (ranging from 76 to 176 L/kg) were within the range of K_{OC} values from these 70 studies.

After the above selection procedure, only sorption measurements from Brouwer et al. (1990) were left for DEA and DIA. The selected K_{OC} values for DEA were 41, 41, 43 and 79 L/kg. The average Freundlich exponent was 0.84. The selected K_{OC} values for DIA were 53, 55, 71 and 107 L/kg. The average Freundlich exponent was 0.97.

After the above selection procedure, no K_{OC} values were left for HA. Addendum 3 of the monograph reports four sorption studies which gave K_{OC} values of 416, 446, 486 and 956 L/kg. The average Freundlich exponent was 0.84.

I.4. Assessment of approaches for PEC-groundwater calculations

The Rapporteur reported a number of modelling studies including calculations for non-FOCUS scenarios. These calculations were carried out before the FOCUS groundwater scenarios had become available. The Committee restricted its assessment to the calculations with FOCUS scenarios because the Rapporteur considered these as most definitive (see Addendum 4 to Annex B).

The first study containing FOCUS scenario calculations is reported on p. 20-21 of Addendum 2 to Annex B (dated February 2001). The Rapporteur concludes that these calculations need to be repeated with different input parameters. Therefore the Committee does not assess these calculations.

The second study containing FOCUS scenario calculations is reported on p. 59-60 of Addendum 4 to Annex B (dated September 2001). These calculations are reported as "first tier modelling approaches" and were carried out with FOCUS PRZM[6] 1.1.1. Atrazine was applied at a rate of 1.5 kg/ha to maize (pre-planting). Table 1 shows the sorption and transformation rate parameters that were used.

Table 1: Sorption and transformation parameters as used for FOCUS PRZM 1.1.1 in the first tier modelling approach.

Substance	K_{OC} (L/kg)	Freundlich exponent	Half-life (d) at reference conditions	Percentage formed from atrazine
Atrazine	91	0.88	-	-
DEA	41	0.95	49	30
DIA	57	0.95	27	11
HA	382	0.93	159	34

For atrazine eight different half-lives were used for the eight FOCUS scenarios that were considered. This was based on an analysis of field experiments in which differences in temperature for the first 6 weeks after application at the trial sites were compared to the climates defined by the scenarios. These half-lives ranged from 31 to 48 days. The parameterisation of the input to the PRZM model implied that these half-lives were not corrected for temperature and moisture in the scenario calculations. These half-lives lead

[6] PRZM: Pesticide Root Zone Model

to a considerably faster transformation of atrazine in the scenario calculation than the reported median half-life of 30 days at reference conditions. For instance, for the Hamburg scenario a half-life of 48 days was used. The annual average air temperature in Hamburg is about 10 °C and a half-life of 48 days at 10 °C corresponds with a half-life of 22 days at the reference temperature of 20 °C. The Rapporteur accepted the justification of these input parameters by the notifier but did not summarize the corresponding reports in the Monograph (for instance the reports cited as Egli-2001a-DP109311, Egli-2001b-DP109305, Egli-2001d-DP109313). Therefore the Committee cannot assess this justification. Its impression is that the procedure is not acceptable because:
a) the whole approach is based on 12 studies carried out at only one site (Les Barges Switzerland)
b) the half-lives appear to be based on spring conditions with higher temperatures than in autumn and winter when most of the leaching occurs.

The Committee accepts all other model input parameters describing sorption and transformation (i.e. the half-lives of DEA, DIA and HA, the percentages formed and the K_{OC} values and Freundlich exponents). However, the Committee cannot accept these scenario calculations in view of the problem with the half-lives of atrazine described in the previous paragraph.

In another series of calculations (considered less appropriate by the Rapporteur), a half-life of atrazine of 49 days at reference conditions was used and all other parameters were equal to those reported in Table 1. The Committee considers the half-life of atrazine to be conservative in view of the median value of 30 days reported in Section 2.2.

Table 2: Results of calculations of PEC groundwater with FOCUS PRZM 1.1.1 (first tier modelling approach assuming a half-life of atrazine of 49 days at reference conditions and parameters as described in Table 1).

Substance	Number of scenarios with concentration above 0.1 µg/L	number of scenarios with concentration below 0.1 µg/L
Atrazine	5	3
DEA	7	1
DIA	3	5
HA	5	3

The Committee accepts the results (shown in Table 2) as a first-tier calculation. The Committee does not expect that the numbers in Table 2 would change significantly if calculations were made with one of the other FOCUS models.

The third study containing FOCUS scenario calculations is reported on p. 61-62 of Addendum 4 to Annex B (dated September 2001). These calculations are reported as "higher tier modelling approach" and were also carried out with FOCUS PRZM 1.1.1. Atrazine was applied at a rate of 1.5 kg/ha to maize (pre-planting).

In this third study the same sorption parameters were used as in the second series but now the K_{OC} values increased with time as follows:
- an increase by a factor 1.3 at 7 days after application for atrazine
- an increase by a factor 1.4 at 7 days after application for DEA
- an increase by a factor 1.7 at 1 day after application for DIA
- no increase for HA as no data were available.

This increase was justified via analysis of adsorption-desorption experiments. In these experiments an adsorption isotherm was measured and thereafter several desorption steps were conducted by replacing the supernatant of the soil-water suspension with clean $CaCl_2$-solution. The equilibration time for each of the adsorption and desorption steps was usually 24 h and most experiments lasted less than a week. The Notifier calculated from these experiments the percentage of substance that was still adsorbed after the last desorption step (called "the permanently adsorbed solute" with symbol "A_P"). It was postulated that the K_{OC} increased by a factor equal to $100/(100-A_P)$. No theoretical justification for this formula was presented but the Rapporteur considered it to be a better approach to reality than the original K_{OC} values. The Rapporteur furthermore stated that this approach will overestimate leaching in the long term.

The Committee does not agree with the Rapporteur because of the following arguments:
1. There is no consensus in the scientific community on such an interpretation of adsorption-desorption experiments. For instance, Altfelder et al. (2000) analysed results of a number of such experiments and found that these could be described well with a two-site kinetic sorpion model (one equilibrium site plus one kinetic site based on a first-order rate equation). If this were also true for the adsorption-desorption experiments considered here, the "permanently adsorbed solute A_P" is physically a quantity of little interest because it will depend on the experimental details of the adsorption-desorption experiments (e.g. the solid-liquid ratio, the volume of supernatant that is replaced, etc.).
2. In reality, the adsorption process takes place in soil. The analysed adsorption-desorption experiments were conducted in soil-water suspensions with solid-liquid ratios of 0.2 to 1 kg/L. These suspensions were continuously shaken or stirred. There is no guarantee that the kinetics as measured in such soil-water suspensions are valid for soil.
3. In the FOCUS PRZM model the increase of the K_{OC} takes place for the whole soil column considered. So the K_{OC} increases also for deeper soil compartments that are still free of substance when the increase is assumed to occur. This is unlikely to occur in reality and may thus lead to an overestimation of sorption by the model. So there is no guarantee that this approach will overestimate leaching.
As a result, the Committee does not accept the use of these increased K_{OC} values.

In this third study, shorter half-lives were used for atrazine and all metabolites. The half-lives of atrazine, DEA and HA were decreased by a factor 2.3 to account for enhanced transformation. For DIA a half-life of 16 d was used based on similar considerations. The Committee agrees with the Rapporteur that there is sufficient evidence for enhanced transformation of both atrazine and its metabolites for soils with pH above 6 (for the metabolites the evidence is mainly based on measurements of increased mineralisation rates). However, the enhanced transformation was assumed to take place for all FOCUS groundwater scenarios whereas three of the eight FOCUS scenarios considered have pH values below 6 (Hamburg, Okehampton and Porto). The Committee considers the pH to be part of the scenario definition and does therefore not accept use of enhanced transformation rates for these scenarios. The Committee accepts use of enhanced transformation rates for the FOCUS scenarios Kremsmünster, Chateaudun, Piacenza, Thiva and Sevilla.

As a result of the above considerations the Committee does not accept the results obtained with the higher tier modelling approach in this third study.

II. Question 2:

Does the Committee agree that the available monitoring data show that in large areas, application of atrazine and simazine under the intended conditions (i.e. max. 0.75 kg a.s./ha in northern Member States and max. 1.0 kg a.s./ha in southern Member States on maize and sorghum in spring) will not result in concentrations of the active substances or their breakdown products in excess to 0.1 µg/L in groundwater ?

Opinion on question 2:

The Committee considered available evidence from lysimeter studies (scale of 1 m^2), field monitoring studies (scale of ha) and of monitoring studies at regional scale. Two of the three soils studied in lysimeter studies resulted in concentrations of atrazine or de-ethylatrazine in lysimeter leachate exceeding 0.1 µg/L indicating the potential of atrazine to contaminate groundwater. European field monitoring studies at four sites with cropped soils gave variable results: concentrations of atrazine and its de-ethylatrazine and de-isopropyl atrazine were sometimes above 0.1 µg/L and sometimes below 0.1 µg/L. Monitoring studies in wells at a regional scale in France, Greece, Spain and Portugal showed only incidental exceedance of the 0.1 µg/L concentration for atrazine and de-ethylatrazine. However, the reports of these studies justified the sampling strategy insufficiently. The Committee considers the resulting interpretation problems so serious that they can even not be solved by considering the reduction in use rates proposed by the notifier. Therefore it is the Committee's opinion that available monitoring data does not demonstrate that concentrations of the active substance or its breakdown products will not exceed 0.1µg/l in groundwater and the Committee expects that for soils with pH above 6 concentrations of atrazine and its breakdown products will not exceed 0.1µg/l.

Scientific background on which the opinion is based:

II. 1 Introduction

The applied dosages indicated in the concentration are lower than those used in the past (e.g. about 1 to 3 kg/ha in northern Member States). The Committee expects that the concentrations in groundwater are directly proportional to the dosage of atrazine and has used this assumption in its considerations.
To answer the question, the Committee summarizes below the relevant data on atrazine leaching that were made available. Information on transformation in water-saturated subsoils is included because this may be relevant for interpretation of groundwater monitoring studies.

II. 2. Transformation rates in water-saturated subsoils.

The transformation rate of atrazine was studied in five water-saturated sandy subsoils at 10°C. The soils were collected between 1.8 and 3.5 m depth in the Netherlands. Their pH ranged from 4 to 8 and their redox potential from 0.1 to 0.7 mV. In three subsoils with pH ranging from 4 to 5 and redox potentials ranging from 0.6 to 0.7 mV half-lives of atrazine ranging from 0.9 to 1.6 year were found. In one subsoil with a pH of 7.6 and redox potential of 0.4 mV no measurable transformation was found on a time scale of

years. This indicates that atrazine half-lives are in the order of 1 year for aerobic subsoils with low pH but much longer for aerobic subsoils with high pH. In the last subsoil (pH of 7 and a redox potential of 0.1 mV) a half-life of about 0.15 year was found. This indicates that atrazine may be transformed rapidly under anaerobic conditions.

The above studies show that transformation rates of atrazine in aerobic subsoils are slower at high pH than at low pH. The studies with topsoils showed the opposite effect: enhanced transformation was only demonstrated for soils with pH above 6. This is not conflicting information because enhanced transformation is unlikely to occur in subsoils (the subsoils are exposed to atrazine concentrations that are orders of magnitude lower than the concentrations in topsoils).

II. 3. Lysimeter studies

Lysimeter studies at two sites were reported: one in Germany with two soils and one in Switzerland with one soil. In Germany, 1 kg/ha of atrazine was sprayed onto a silt loam and a loamy sand soil in May. Both soils were cropped with maize in the first year and with winter wheat and winter barley in the following years. The depth of the lysimeter was 1.1 m. The organic carbon content and pH of the soils were not reported. Annual rainfall was about 780 mm in the first year and about 820 mm in the second year. Percolated amounts of water ranged from 160 to 220 mm per year. The maximum annual average concentration of atrazine was 0.3 µg/L for the silt loam soil and 0.06 µg/L for the loamy sand soil. For DEA these figures were 1.0 µg/L for the silt loam soil and 0.8 µg/L for the loamy sand soil. Annual average concentrations of unidentified radioactivity (not being CO_2) ranged from 3 to 6 µg/L. The Committee assumes that this unidentified radioactivity was checked for presence of DIA and HA (this was not reported in the monograph).

In Switzerland, 1 kg/ha of atrazine was sprayed onto a loamy sand soil in May. The soil was cropped with maize in the first year and with winter rye and winter wheat in the following years. The depth of the lysimeter was 1.2 m. The organic carbon content and pH of the soil was not reported. Annual rainfall was about 910 mm in the first year and about 1130 mm in the second year. The cumulative water percolation over the two-year study period was about 800 mm. The maximum annual average concentration of atrazine was 0.03 µg/L and that of DEA was 0.08 µg/L. Three unknown metabolites were detected in the leachate with maximum annual average concentrations ranging from 0.2 to 1.8 µg/L.

In summary lysimeter studies with three soils resulted in maximum annual average concentrations of 0.03, 0.06 and 0.3 µg/L for atrazine and of 0.08, 0.8 and 1.0 µg/L for DEA. The Committee considers the percolated amounts of water in the German lysimeter study (160-220 mm per year) too low to represent a realistic worst case for north-west European conditions.

II. 4. Monitoring studies on field scale

Table 3 summarises the European monitoring studies at field scale for cropped soils that were made available.

Table 3: Summary of available European monitoring studies on atrazine leaching to groundwater at field scale for cropped soils.

Location	Annual dose of atrazine	Crop	Soil properties	What sampled and when ?	Resulting concentrations (μg/L)
Lorsch (Germany)	1-2 kg/ha (many years)	maize	topsoil: loamy sand to sandy loam with 2.5% organic carbon and pH of 5	groundwater in six wells at 2 m depth in 1990	0.05-0.15 for atrazine and 0.05-0.2 for DEA in three wells; no detections in other wells
two sites in Denmark	1.2-3.4 (for 3 to12 year)	maize	sandy soils (no other information)	groundwater at 1.8-2.9 m depth reported in 1992	<0.01 to 0.05 for atrazine; DEA and DIA not detected
Bergeijk (Netherlands)	up to 1.2 kg/ha before 1984 and 0.5 kg/ha thereafter	maize	very sandy soil (no other information)	groundwater from four shallow wells	before 1990 >0.1 for atrazine, DEA and DIA; in 1990 and 1991 <0.1 for atrazine, DEA and DIA

These field studies indicate that atrazine concentrations are close to the 0.1 μg/L value (in some cases below, in others above). Further interpretation is impossible because of the limited information provided (e.g. no information on meteorological conditions and limited information on soils). Moreover the number of field studies should have been much larger to enable extrapolation to large areas.

II. 5. Monitoring studies on larger scales

Table 4 summarises information in the monograph on groundwater monitoring in a number of member states. No information was given on groundwater depths and use of atrazine in the areas that were sampled.

Table 4 Summary of groundwater monitoring studies on atrazine conducted at Member State level. The percentages refer to the percentage of the samples that exceeded a concentration of 0.1 μg/L. Empty cells in the table imply that no information was available.

Country	Period	Total number of samples	% > 0.1 μg/L for atrazine	% > 0.1 μg/L for DEA	% > 0.1 μg/L for DIA	% > 0.1 μg/L for HA
Germany		106-4648	6	2	0.1	0
Netherlands		105	45	37	30	
Italy		3506	26			
Sweden	1985-90	230	5			
Austria	1992	744	24	30	3	
UK	1992-94		9-11			

Additionally two monitoring studies from Belgium were reported. A study from 1990 showed no atrazine above 0.1 μg/L in 75 groundwater samples from different locations (no further information about sampling depths and soils etc.). In another Belgian study from 1991-1996, 2046 well samples were analysed: in 98% of the samples atrazine concentrations were below 0.1 μg/L and in 91% of the samples DEA concentrations were below 0.1 μg/L (which implies that in 2 and 9% of the samples the concentrations were above 0.1 μg/L).

A letter from the BBA to the EC described results of groundwater monitoring results in Germany from 1996 to 1999. A total ban of atrazine in Germany became effective in 1991. About 23 000 samples were analysed for atrazine of which 3% contained concentrations above 0.1 μg/L. About 22 000 samples were analysed for DEA of which 7% contained concentrations above 0.1 μg/L. The samples were taken in at least 10 federal states each year.

A letter from the Federal Environment Agency of Austria to the EC reported results of groundwater monitoring studies in Austria from 1992 to 1997. In 1992 the application rate of atrazine was reduced to 0.5 kg/ha and all authorisations for atrazine use were withdrawn in 1995. About 18 000 samples were analysed between 1992 and 1995. The concentrations of atrazine, DEA and DIA were above 0.1 μg/L in 23, 32 and 2% of the samples, respectively. About 12 000 samples were analysed between 1995 and 1997. The concentrations of atrazine, DEA and DIA were above 0.1 μg/L in 15, 24 and 1% of the samples, respectively.

Because of the limited information provided the Committee cannot use the results of the above monitoring studies in its answer to the question. For example it is not clear which percentage of the samples could have contained atrazine (so non-relevant[7] negatives are not excluded) and to which extent non-agricultural uses like industrial weed control or point source pollution influenced the result (so non-relevant positives are not excluded either). Such factors may be partly responsible for the large variability between the percentages found in the above table.

A groundwater monitoring study from south west France was reported in the monograph. In the area considered 80% of the farms grew maize. In the 1980s atrazine was used at a rate of 3 kg/ha and from 1990-1997 the rate was reduced to 1.5 kg/ha with a further reduction to 1.0 kg/ha in 1997. Groundwater was sampled in 1998 from 13 groundwater wells (water depth 9-60 m below the surface) and no concentrations of atrazine above 0.1 μg/L were found.

In Addendum 4 to Annex B of the monograph the Rapporteur copied a proposal from the notifier on examples of "safe use" areas. This proposal contained results of three groundwater monitoring studies from Greece, Portugal and Spain which follow below. The Committee notes that the Rapporteur did not summarize these studies. The Committee included information on the Greek study sent by the notifier in two documents ("EU review of atrazine and simazine - Comments to questions referred to SCP concerning the assessment of the risk of atrazine and simazine to groundwater" and

[7] In this opinion the term "non-relevant" refers to non-relevant groundwater samples for monitoring studies, therefore in this context "non-relevant" is not related to and should not be confused with the term "non-relevant metabolite".

"EU review of atrazine and simazine - Proposal of safe use areas with regard to residues in ground- and surface water").

The groundwater monitoring study from Greece started in 1996 in five main maize regions of Greece. At 10-15 sites in each of these five regions a well was sampled several times over a 15 month period. The wells were existing wells used for drinking water supply or irrigation. Depth of the groundwater was reported to range between less than 1 m to 70 m. Further details (e.g. rainfall during the period, soil types) were not reported. In three regions all concentrations of atrazine and DEA were below 0.05 µg/L. In the Thessaloniki region two wells had atrazine concentrations above 0.1 µg/L but this was attributed to point source pollution. In the Ardas/Evros region four wells had atrazine or DEA concentrations above 0.1 µg/L (up to 0.7 µg/L); this was attributed to an unfavourable combination of agricultural practice (60 mm of irrigation shortly after application) and soil and aquifer properties. The age of the groundwater in these four wells was measured via isotopes and ranged between 4 and 9 years.

The groundwater monitoring study from Portugal was conducted in the region Ribatejo which was reported to be the main maize growing area in Portugal. In total 18 wells were sampled twice. Their depths ranged from 15 to 182 m (five wells between 15 and 25 m, five between 25 and 100 m and five between 100 and 182 m). The concentrations of atrazine and DEA in 16 wells were below 0.03 µg/L but in two wells higher concentrations of atrazine and DEA were found (0.07-0.17 µg/L for atrazine and 0.06-0.14 µg/L for DEA). The depths of these wells were 15 and 24 m.

The groundwater monitoring study from Spain was conducted in the region Albacete which was reported to be one of the most important maize growing regions in Spain. Three wells and one spring were sampled twice. The well depths ranged from 30 to 110 m. The concentrations of atrazine and DEA were below 0.01 µg/L in all samples.

The results of these last four monitoring studies could in principle be used to answer the question. However, the Committee has a number of interpretation problems with these studies:
1. The monitoring studies are not documented appropriately; see Aden et al. (2002) for a detailed list of the information that is needed.
2. In general it has to be demonstrated for each well that its water originates from a relevant infiltration area in the relevant period (i.e. from the agricultural fields in the period where the substance was used). For instance, a significant fraction of the sampled wells were deeper than 50 m depth. This water could have infiltrated more than 50 years ago depending on the hydrogeological conditions. However, the Rapporteur did not provide this information. The results from the Portugese monitoring study may illustrate this interpretation problem: only two of the 18 wells contained measurable concentrations. However, the two contaminated wells had filter depths of 15 and 24 m and only five of the 18 wells had depths shallower than 25 m.
3. It is not clear in many cases whether wells are observation wells or perhaps abstraction wells used for pumping drinking water. Observation wells give information about a local concentration whereas abstraction wells may give information about the concentration in a mixture of water of different age. Abstraction wells are therefore usually less suitable for evaluating groundwater contamination.
4. If monitoring wells are used that are very deep (e.g. deeper than 100 m) it needs to be demonstrated that abstraction of drinking water at shallower depths is not feasible in

practice. Otherwise the Committee considers data from such a well not appropriate for demonstration that atrazine does not leach to groundwater at concentrations above 0.1 μg/L under the intended conditions of use: atrazine may have degraded before reaching such a deep well whereas concentrations above 0.1 μg/L may be present at shallower depths.
In summary, these interpretation problems imply that the Committee cannot assess which of the reported concentrations in groundwater should be ignored because they are not considered to be relevant (as described earlier both non-relevant[8] positives and non-relevant negatives are possible). The population of relevant concentrations in groundwater may differ considerably from the combined population of relevant and non-relevant concentrations (see for instance the considerations with respect to the Portuguese monitoring wells in item 2).

The Committee recognizes that the proposed use rates are lower than the rates used in the areas that were monitored. As a result of the proposed reduced rates, it may be expected that the concentrations in groundwater decrease by a factor 2 to 3 (considering the normal agricultural use only). However, the Committee considers the uncertainty resulting from the problem of the non-relevant assessment much larger than this factor 2 to 3. As a result of these considerations the Committee cannot give a positive answer to the question based on these monitoring studies.

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[8] In this opinion the term "non-relevant" refers to non-relevant groundwater samples for monitoring studies, therefore in this context "non-relevant" is not related to and should not be confused with the term "non-relevant metabolite".

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