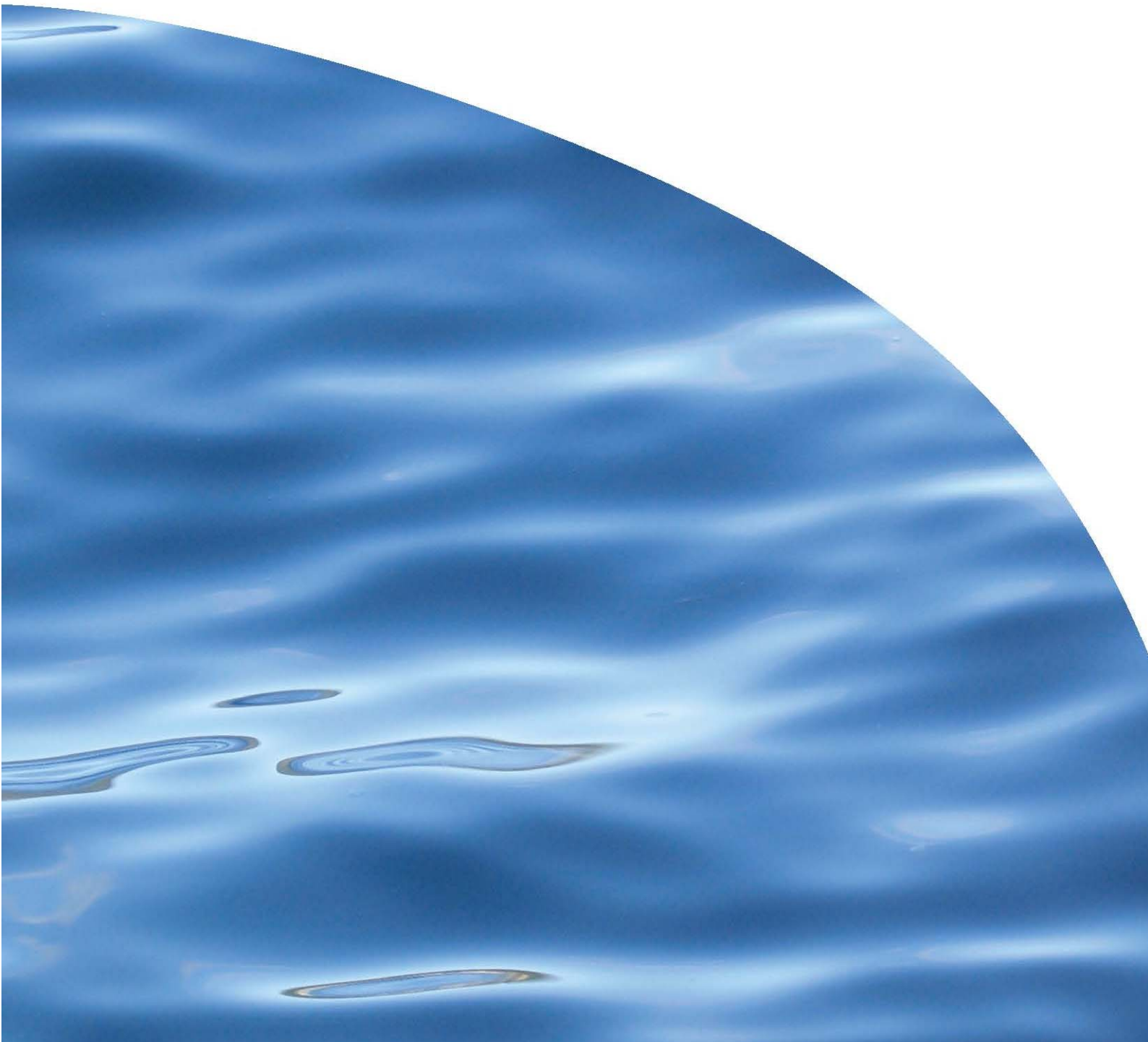
CAWTHRON INSTITUTE

REPORT NO. 2357

ECOTOXICITY REVIEW OF 26 PESTICIDES



ECOTOXICITY REVIEW OF 26 PESTICIDES

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Prepared for Nelson City Council

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EXECUTIVE SUMMARY

The Nelson City Council (NCC) is in the process of submitting a resource consent application to use a range of pesticides for the control of vegetation and pests on NCC administered parks and reserves. The Council has contracted Cawthron Institute (Cawthron) to review the ecotoxicology of 26 pesticides being considered as part of their application.

To characterise environmental risk of the 26 pesticides, the main international databases (*i.e.* data from World Health Organisation (WHO) Pesticide Data Sheets (PDSs), US Environmental Protection Agency (ToxNet and PAN), European Chemicals Agency (ECHA), Canadian (Health Canada), AGRITOX database on plant protection substances (France), Australian and New Zealand Environment and Conservation Council (ANZECC) and Rotterdam Convention database of chemicals) were reviewed and the most relevant information collated into this report. To simplify the interpretation of the data, the findings from the review have been summarised in Table 1.

A classification framework has been adapted using a scoring system (see *e.g.* McBrien, 1987; and the description of the system of scoring in the Explanations section) for the purpose of assessing the environmental risk of each pesticide. Parameters are weighted to reflect their relative importance to the risk characterisation of each pesticide, which is then allocated a score that is depicted as a colour *e.g.* low risk (green), medium risk (yellow) and high risk (red).

The colour ranking allocated for each pesticide is based on key indicators including:

- threshold concentration for the 95% protection level of species (hazardous concentration 5%; HC5)
- the physico-chemical properties of the chemical (potential to bioaccumulate and persistence in the environment)
- regulatory status in other countries.

When the protection level was uncertain or when the chemical was either not approved (*e.g.* pending renewal) or banned for use in at least one country, a medium risk ranking (yellow) was applied as a precautionary measure.

This colour ranking of each pesticide in Table 1 provides an ‘at-a-glance’ summary of the relative potential environmental risk, for example a green-ranked pesticide may potentially have less environmental impact than a pesticide allocated a yellow or red ranking. But this should not be interpreted as an endorsement for its unrestricted use. These rankings are based on current information pertaining to risk characterisation, but do not take into account the following:

- local environmental conditions and potential receptor species

- field application rates
- application timing
- formulation used.

In addition, the stability of the pesticides in water does not take into account the fate of degradation products and their potential toxicity. So these pesticide rankings should be used as a starting point to a full risk assessment.

This review confirmed of the 26 pesticides assessed, five pesticides were banned for use in at least one country (either for human health and / or environmental reasons): 2,4D (Norway), chlorpyrifos (Saudi Arabia), mecoprop (Thailand), MCPA (Thailand), and MCPB (Thailand).

The Rotterdam Convention assists Parties to reduce risks from certain hazardous pesticides in international trade. The current list of pesticides registered with the Rotterdam Convention includes over 6,000 chemicals. A recommendation as a result of this review is that NCC could consider updating the list of pesticides in their resource consent application to include some of those on the Rotterdam Convention list. These may provide more sustainable alternatives to the current pesticides NCC uses.

Table 1. Scores (weighted) for the parameters used to derive the colour ranking for the 26 pesticides assessed (see explanatory note below Table 1).

Agri-chemical	Category ranking							Environmental ranking
	log Kow	Koc	*GUS*	BCF	Half-life water hydrolysis	Half-life in soil	HC5	
Picloram	1	1	*6.03*	6	20	8	12	48
Triclopyr	1	3	*3.69*	6	2	6	20	38
Mecoprop	1	2	*2.29*	4	20	2	36	65
Dicamba	1	2	*1.75*	6	6	4	20	39 R
Dichlorprop	4	3	*2.39*	4	20	5	36	72
2,4-D	1	3	*1.62*	4	20	6	12	46 R
Ethofumesate	3	3	*3.19*	6	20	10	20	62
Glyphosate	3	5	*-0.49*	2	20	10	20	60*
Metsulfuron	1	2	*n/r*	6	20	6	4	39 P
Terbuthylazine	4	3	*3.07*	6	20	10	20	63
Haloxyfop	3	3	*2.03*	6	20	6	44	82
MCPA	1	2	*2.94*	4	20	4	36	67
MCPB	2	3	*1.66*	4	20	2	4	35 R
Paclobutrazole	4	3	*3.44*	6	20	10	36	79
Copper Hydroxide	1	5	*-0.32*	6	20	20	44	96
Lime Sulphur	3	4	*n/r*	6	20	20	20	73
Azoxystrobin	3	4	*2.6*	6	20	10	36	79
Mancozeb	2	4	*-1*	4	2	2	36	50
Triforine	3	4	*1.63*	6	2	4	36	55
Propiconazole	4	4	*1.51*	8	8	20	36	80
Chlorothalonil	3	4	*0.7*	8	12	6	44	77
Tau-fluvalinate	6	5	*-0.76*	10	4	10	52	87
Methiocarb	3	4	*0.17*	6	4	8	36	61
Chlorpyrifos	5	5	*0.15*	10	8	6	52	86
Clofentezine	3	3	*n/r*	6	2	10	36	60
Calteryx	3	3	*4.22*	6	6	20	28	66

Note: Category descriptions

- Kow: Partition coefficient, is a measure of how a chemical will distribute between two immiscible solvents: water (a polar solvent) and octanol (a relatively non-polar solvent).
- Koc: Adsorption coefficient is a measure of how strongly a chemical adheres to soil in preference to remaining dissolved in water.
- BCF: bioconcentration factor, describes the accumulation of toxicants (i.e. from the water to the organism), for aquatic animals.
- GUS: Groundwater Ubiquity Score, an indicator of a chemical potential for leaching into groundwater (‡ not taken into account for the ranking hence use of grey font). Refer to Definitions table for the leaching likelihood).
- HC5: A hazardous substance for 5% of the species population (95% protection level). Derived from aquatic animals' data.
- P: Precautionary ranking (lack of data)
- R: Regulatory ranking (banned or pending approval)
- Grey cells indicate non-reported values replaced by intermediate score
- * Precautionary from vertebrate studies (non- reported in the table)

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GLOSSARY

Acronym	Definition
ai	Active ingredient
as	Active substance
ANZECC	Australian and New Zealand Environment Conservation Council
BCF	Bioconcentration factor
bw	Body weight
DPR	Department of Pesticide Regulation of California
DT_{50}	Degradation Time of the substance to reach 50% of its the initial concentration (half-life)
d.	day
d. wt.	dry weight
EC_{50}	Effective Concentration that leads to half-maximal response
ECHA	European Chemical Agency
EPA	Environment Protection Agency
EU-WFD	European Commission - Water Framework Directive
g	gram
GUS	Groundwater Ubiquity Score
GWL	Groundwater Protection List
ha	Hectare
HC5	Hazardous concentration for 5% of the species
IC_{50}	50% Inhibitory Concentration
kg	kilogram
Koc	Adsorption coefficient in soil
Kow	Octanol-water partition coefficient
L	litre
$LC(D)_{50}$	50% Lethal Concentration (Dose)
LOEC	Lowest Observed Effect Concentration
mg	Milligram
µg	microgram
NOEC	No Observed Effect Concentration
PNEC	Predictable No-Effect Concentration
ppm	part per million (mg/kg, mg/L, g/m^3)
wt	Weight
WHO	World Health Organisation

DEFINITIONS

Term	Definition
Acute toxicity	This is the intrinsic property of a substance to be injurious to an organism in a short-term exposure to that substance. Lethality is the endpoint associated with acute toxicity in this document where the benchmarks of toxicity are LC_{50}'s. It is usually determined in controlled laboratory animal exposure studies. • Mammals, birds > 2000 mg/L = Low 100-2000 mg/L = Moderate < 100 mg/L = High • Honey bees, fish, aquatic invertebrates, sediment dwelling organisms > 100 mg/L = Low 0.1 - 100 mg/L = Moderate < 0.1 mg/L = High • Algae, aquatic plants > 10 mg/L = Low 0.01 - 10 mg/L = Moderate < 0.01 mg/L = High
BCF	The concentration of the pesticide in tissue per concentration of chemical in the ambient environment. This describes the accumulation of pollutants through chemical partitioning from, for instance, the aqueous phase into an organic phase, such as the gill of a fish.
Chronic toxicity	This state implies adverse effects during or after relatively long-term exposures to one or more contaminants. In this document it is associated with effects that are related to changes in reproduction, growth metabolism, mobility, or other sub-lethal biological variables (*e.g.* behaviour) being observed.
EC_{x-t}	**Effective Concentration** is the generic term for a concentration of substance or material that is estimated to cause some defined effect on a proportion (x%) of the test organisms after a defined period of exposure (t). This kind of endpoint allows the classification and the comparison of the toxic potency or intensity of different chemicals. More terms can be derived to describe specific effects (*e.g.* lethality, inhibition): - **LC_{x-t}** (Lethal Concentration) is the concentration of substance or material that is estimated to be lethal to a proportion (x%) of the test organisms after a defined period of exposure (t). This is an acute toxicity indicator. - **IC_{x-t}** (Inhibitory Concentration) is the concentration of substance or material that is estimated to have an inhibitory effect (*e.g.* growth, mobility) on a proportion (x%) of the test organisms after a defined period of exposure (t). This is a chronic toxicity indicator.
GUS	The **Groundwater Ubiquity Score** is an indicator of a chemical potential for leaching into groundwater. It is based on the environmental fate properties of the chemical and takes no account of environmental conditions. It is not a substitute for modelling and risk assessment studies. If GUS > 2.8: pesticide likely to leach If GUS 1.8 - 2.8: leaching potential is marginal if GUS < 1.8: pesticide unlikely to leach
Half-life (DT_{50})	Time required for the pesticide concentration under defined conditions to decline (break down into degradation products) to 50% of the original amount after an

<table>
<tr><th>Term</th><th>Definition</th></tr>
<tr><td></td><td>application. This time is often expressed as a range (for example, 1-3 days, etc.) because the rate of pesticide breakdown depends on a variety of factors including temperature, soil pH, soil microbe content and whether or not the pesticide is exposed to light, water and oxygen. It is worth noting that many of the breakdown products themselves are toxic and may have significant half-lives as well.</td></tr>
<tr><td>HC5</td><td>Hazardous concentration for 5% of the species; this concentration derived from literature data is expected to protect 95% of species.</td></tr>
<tr><td>Henry's Law Constant</td><td>Amount of gas absorbed by a given volume of liquid at a given temperature. This amount is directly proportional to the partial pressure of that gas in equilibrium with that liquid. As such it provides an indication of the preference of a chemical for air relative to water i.e. its volatility. Henry's Law Constant is usually quoted in $Pa.m^3$/mole (or in a dimensionless form) at a given temperature (20°C).</td></tr>
<tr><td>Koc (adsorption coefficient)</td><td>The adsorption coefficient, Koc, is a measure of how strongly a chemical adheres to soil in preference to remaining dissolved in water. Koc is formally defined as the ratio of the mass of pesticide adsorbed per unit mass of soil to the mass of the pesticide remaining in solution at equilibrium. Pesticides with high Koc values (>1000) are typically not very water soluble and will preferentially adhere to soils rather than be dissolved in water. This means that pesticides in this class are unlikely to be carried off-site in runoff as dissolved substances; instead, they are transported on sediment particles.
Chemicals with lower values (< 500) tend to move more with water than be adsorbed to sediment. Some pesticides are strongly bound to other soil components such as clay surfaces. For some pesticides Koc will be very pH sensitive.
<table>
<tr><th>Koc</th><th>Mobility</th></tr>
<tr><td>< 15</td><td>Very mobile</td></tr>
<tr><td>15 - 75</td><td>Mobile</td></tr>
<tr><td>75 - 500</td><td>Moderately mobile</td></tr>
<tr><td>500 - 4000</td><td>Slightly mobile</td></tr>
<tr><td>> 4000</td><td>Non-mobile</td></tr>
</table></td></tr>
<tr><td>Kow (partition coefficient)</td><td>The octanol-water partition coefficient, Kow, is a measure of how a chemical will distribute between two immiscible solvents: water (a polar solvent) and octanol (a relatively non-polar solvent). Pesticides with a long half-life and high Kow have been shown to bioaccumulate in the food chain. It is usually expressed as a logarithm (base 10). The larger the log the more likely the substance will bioaccumulate</td></tr>
<tr><td>LOEC</td><td>Lowest Observed Effect Concentration is the lowest concentration of a test substance or material which is observed to have a statistically significant adverse effect on the test organisms for a defined time of exposure and under the test conditions, relative to the control.</td></tr>
<tr><td>Mobility</td><td>Ability of a substance to be transported through the environment</td></tr>
<tr><td>NOEC</td><td>No Observed Effect Concentration is the highest concentration of a test substance or material which is observed not to have a statistically significant adverse effect on the test organisms for a defined time of exposure and under the test conditions, relative to the control.</td></tr>
<tr><td>pKa (dissociation constant)</td><td>Strengths of acids and bases can be indicated on a common scale at 25°C. Defined as the negative logarithm of the acidity constant Ka. The lower the pKa the stronger the acid. For example acetic acid has a pKa of 4.75 whilst sulphuric</td></tr>
</table>

Term	Definition
	acid has a pKa of -3.0. pKa is used here as an indicator of the potential of a compound to form ions in water. Many pesticide active substances are either permanently ionic or will change ionic state somewhere in the range of the pH of environmental soils and water. Knowing the ionic sate of a pesticide provides important information on its potential mobility and persistence in the environment.
Vapour pressure	The pressure at which a liquid is in equilibrium with its vapour at 25°C. It is a measure of the tendency of a material to vapourise. The higher the vapour pressure the greater the potential.

EXPLANATIONS

Term	Explanation
Registration for use	If a pesticide is registered for use in a country, it is legally allowed to be used in that country. The registration status of pesticides in a number of different countries has been collected by the Pesticide Action Network.  Countries (in green) from which registration data were obtained.
Toxicology	**Acute toxicity** **WHO Toxicity Classification (WHO 2009)** / **Rat LD_{50} (mg of chemical per kg of body weight)** **Class** | **Description** | **Solids (oral)** | **Liquids (oral)** | **Solids (dermal)** | **Liquids (dermal)** **Ia** | Extremely hazardous | < 5 | < 20 | < 10 | < 40 **Ib** | Highly hazardous | 5-50 | 20-200 | 10-100 | 40-400 **II** | Moderately hazardous | 50-500 | 200-2,000 | 100-1,000 | 400-4,000 **III** | Slightly hazardous | > 500 | > 2,000 | > 1000 | > 4,000
	Endocrine disruption • **EU list**: List of substances for further evaluation of their role in endocrine disruption. The list is to be used to identify substances for priority testing. • **Benbrook list**: Report listing a number of compounds as suspected endocrine disruptors (Benbrook 1996). • **Keith list**: List of suspected endocrine disrupting chemicals with their

<table>
<tr><th>Term</th><th>Explanation</th></tr>
<tr><td></td><td>effects on humans and the environment (Keith 1997).
• Colborn list: A list of suspected endocrine disrupting chemicals with their effects on humans and the environment (Colborn et al. 1993; Colborn et al. 1996).</td></tr>
<tr><td></td><td>Reproductive and developmental toxicity
• CA Proposition 65 Developmental Toxin: Pesticides determined by the state of California to cause reproductive and developmental harm, e.g. birth defects, infertility, sterility and impairment of normal growth and development. A list of chemicals "known to the State to cause reproductive and developmental toxicity" is maintained by the State of California under the Safe Drinking Water and Toxic Enforcement Act of 1986 (Proposition 65). The absence of a chemical on this list does not necessarily mean it is not a reproductive or developmental toxicant. It may mean that it has not yet been evaluated by the agencies responsible.
• U.S. Toxics Release Inventory (TRI) Developmental Toxin: U.S. EPA publishes a list of chemicals that must be reported. A chemical is placed on the list if it is toxic to humans or damaging to the environment. The current TRI toxic chemical list contains approximately 650 individually listed chemicals and 30 chemical groups. Of this group, only 350 individual chemicals and 25 chemical groups are pesticides or related compounds. Of these pesticide chemicals, only 222 have been formally ranked through the TRI program for their toxicity. Toxicity categories evaluated for the TRI list of chemicals includes acute toxicity, carcinogenicity, reproductive and developmental toxicity, environmental toxicity and toxicity to organ systems including cardiovascular, liver, gastrointestinal, kidney, immune, hematological, and respiratory systems.</td></tr>
<tr><td>Ecotoxicology</td><td>Aquatic organisms acute toxicity categories (Kamrin 1997)
<table><tr><th>Toxicity category</th><th>LC_{50} (µg/L)</th></tr><tr><td>Very highly toxic</td><td>< 100</td></tr><tr><td>Highly toxic</td><td>100-1 000</td></tr><tr><td>Moderately toxic</td><td>1 000-10 000</td></tr><tr><td>Slightly toxic</td><td>10 000-100 000</td></tr><tr><td>Not acutely toxic</td><td>> 100 000</td></tr></table></td></tr>
<tr><td>Scoring system used for each category</td><td>The system of scoring used for each category (i.e. Kow, BCF, HC5, Koc, ½ life and environmental ranking) to arrive at the final rankings for each pesticide is as follows:
<table><tr><th>Kow</th><th>Score</th></tr><tr><td>< 0.8</td><td>1</td></tr><tr><td>0.8 – < 2</td><td>2</td></tr><tr><td>2 – < 3.2</td><td>3</td></tr><tr><td>3.2 – < 4.5</td><td>4</td></tr><tr><td>4.5 – < 5.5</td><td>5</td></tr><tr><td>5.5 <</td><td>6</td></tr></table><table><tr><th>BCF</th><th>Score</th></tr><tr><td>< 1</td><td>1</td></tr><tr><td>1–9</td><td>2</td></tr><tr><td>10–99</td><td>3</td></tr><tr><td>100–999</td><td>4</td></tr><tr><td>1 000–9 999</td><td>5</td></tr><tr><td>> 10 000</td><td>6</td></tr></table><table><tr><th>HC5 (µg/L)</th><th>Score</th></tr><tr><td>0.01 – < 0.5</td><td>13</td></tr><tr><td>0.5 – < 10</td><td>11</td></tr><tr><td>10 – < 500</td><td>9</td></tr><tr><td>500 – < 1 000</td><td>7</td></tr><tr><td>1 000 – < 5 000</td><td>5</td></tr><tr><td>5 000 – < 10 000</td><td>3</td></tr><tr><td>≥ 10000</td><td>1</td></tr></table></td></tr>
</table>

Term	Explanation

Koc	Score
0 – < 15	1
15 – < 75	2
75 – < 500	3
500 – < 4000	4
≥ 4000	5

½ life (days)	Score
0 – <10	1
10 – < 30	2
30 – < 60	3
60 – < 90	4
90 – < 180	5
≥ 180	10

Environmental ranking	Score
Green	< 55
Yellow	55–79
Red	> 79

Note: The weighting factors Kow ×1, Koc × 1, BCF× 2, half-life × 2, HC5 × 4 were applied to the raw scores prior to summation.

1. INTRODUCTION

The Nelson City Council (NCC) is in the process of seeking approval to use a number of agri-chemicals for the control of vegetation and pests on NCC administered parks and reserves. The Council has contracted Cawthron Institute (Cawthron) to provide a report on the toxicity and risks of chemicals intended for that use. The active ingredients for review comprised the following 26 compounds:

- 2,4-D
- Azoxystrobin
- Calteryx (chlorantraniliprole)
- Chlorothalonil
- Chlorpyrifos
- Clofentezine
- Copper hydroxide
- Dicamba
- Dichlorprop
- Ethofumesate
- Glyphosate
- Haloxyfop
- Lime sulphur
- Mancozeb
- MCPA
- MCPB
- Mecoprop
- Methiocarb
- Metsulfuron
- Paclobutrazol
- Picloram
- Propiconazole
- Tau-fluvalinate
- Terbuthylazine
- Triclopyr
- Triforine.

Data were mainly obtained from the World Health Organisation (WHO), US Environmental Protection Agency (ToxNet and PAN), European Chemicals Agency (ECHA), Canadian (Health Canada), AGRITOX database on plant protection substances (France), Australian and New Zealand Environment and Conservation Council (ANZECC) and Rotterdam Convention database of chemicals. There are some inconsistencies in the use of units and missing information for some chemicals, *e.g.* missing values, no studies, no regulatory information available. This is a reflection of the variety of sources used for this review or is an information gap in the particular database consulted.

This report provides for each agri-chemical, information pertaining to the following aspects:

- Chemical structure and other forms
- Physico-chemical properties
- Toxicology and ecotoxicology information
- Environmental fate information
- Environmental standards or regulations
- Important user information.

The level of information available from the international databases for this review is extensive and challenging to interpret. To facilitate the interpretation of information a ranking system was developed from an existing framework (described below in Section 2).

2. PESTICIDE RANKINGS

The classification framework was developed using a scoring system approach as described in McBrien (1987). The scored parameters were weighted to reflect their relevance and importance to the risk characterisation (*e.g.* Kow × 1, Koc × 1, BCF× 2, half-life × 2, HC5 × 4; see the scoring system description in the Explanations section and note beneath Table 2). Each category was defined as being a third of the range covered by the scores; the lowest scores in green, medium in yellow and highest in red.

The colour ranking is an approach to best estimate the potential environmental risk of the pesticides. For instance, a green coded pesticide will potentially have a lesser impact than a yellow or red but this should not be interpreted as an endorsement for its unrestricted use. This approach reinforces and confirms the overall assessment that was derived from the available information in the databases.

We reviewed the list of 26 pesticides to be considered as part of the consent process. However, the current Rotterdam Convention list of registered pesticides includes over 6000 compounds and some of these could provide suitable and sustainable alternatives to those considered in this review.

Table 2. Depiction of the scores (weighted) of the parameters used to derive the colour ranking for the 26 pesticides assessed (see explanatory note below Table 2).

Agri-chemical	Category ranking							Environmental ranking
	log Kow	Koc	GUS ‡	BCF	Half-life water hydrolysis	Half-life in soil	HC5	
Picloram	1	1	6.03	6	20	8	12	48
Triclopyr	1	3	3.69	6	2	6	20	38
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Haloxyfop	3	3	2.03	6	20	6	44	82
MCPA	1	2	2.94	4	20	4	36	67
MCPB	2	3	1.66	4	20	2	4	35 R
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Azoxystrobin	3	4	2.6	6	20	10	36	79
Mancozeb	2	4	-1	4	2	2	36	50
Triforine	3	4	1.63	6	2	4	36	55
Propiconazole	4	4	1.51	8	8	20	36	80
Chlorothalonil	3	4	0.7	8	12	6	44	77
Tau-fluvalinate	6	5	-0.76	10	4	10	52	87
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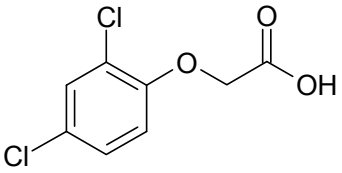
- GUS: Groundwater Ubiquity Score, an indicator of a chemical potential for leaching into groundwater (‡ not taken into account for the ranking hence use of grey font). Refer to Definitions table for the leaching likelihood).
- HC5: A hazardous substance for 5% of the species population (95% protection level). Derived from aquatic animals' data.
- P: Precautionary ranking (lack of data)
- R: Regulatory ranking (banned or pending approval)
- Grey cells indicate non-reported values replaced by intermediate score
- * Precautionary from vertebrate studies (non- reported in the table)

3. PESTICIDE REVIEWS

3.1. 2,4-D



(Other forms: 2,4 D ethylhexyl ester (2,4D 2-EHE), 2,4-D dimethylamine salt, 2-(2,4-DP) dimethylamine salt)

3.1.1. Physico-chemical properties

Cas number	94-75-7
Name (IUPAC)	2,4-dichlorophenoxy acetic acid
Use class	Herbicide, plant growth regulator
Chemical class	Chlorophenoxy acid
Appearance	white or off-white crystalline powder, slight phenolic odour
Melting point	139.25°C
Boiling point	none
Relative density	Bulk density: 0.66 g/mL, Tap density: 0.81 g/mL
Vapour pressure	1.9×10^{-5} Pa at 25°C
Henry's law constant	1.3×10^{-5} Pa at 25°C
Solubility in water	pH 1 buffered: 311 ± 4 mg/L at 25°C pH 5 buffered: 20031 ± 1149 mg/L at 25°C pH 5 unbuffered: 29934 ± 2957mg/L pH 7 buffered: 23180 ± 590 mg/L at 25°C pH 7 unbuffered: 44558 ± 674 mg/L pH 9 buffered: 34196 ± 1031 mg/L at 25°C pH 9 unbuffered: 41314 ± 335 mg/L
Solubility in organic solvents (at 20°C)	n-hexane 0.03 g/L at 25°C toluene 6.4 g/L dichloromethane 13 g/L methanol ≥810 g/L isopropanol 220 g/L n-octanol 120 g/L acetone 390 g/L ethylacetate170 g/L
Dissociation constant (pKa)	2.73

Partition coefficient (log Kow)	pH 1: 2.70 at 25°C pH 5: 0.18 at 25°C pH 7: - 0.83 at 25°C pH 9: -1.01 at 25°C
Adsorption coefficient (Koc)	20 - 136
Hydrolytic stability (DT_{50})	pH 5: not hydrolyzed at 25°C DT_{50}= estimated to be 2 years pH 7: not hydrolyzed at 25°C DT_{50}= estimated to be 2 years pH 9: not hydrolyzed at 25°C DT_{50}= estimated to be 2 years
Photostability (DT_{50})	12.98 days in sterile aqueous buffer of pH=7 at 25°C
Aerobic Soil Half-life	34 d
Anaerobic Soil Half-life	333 d

3.1.2. Environmental fate

The production of 2,4-D may result in its release to the environment through various waste streams and its use as a systemic herbicide will result in its direct release to the environment. Environmental presence of 2,4-D may also occur as a result of the production and disposal of 2,4-D, and discharge of treated / untreated industrial effluents / wastes.

If released to air, a vapour pressure of 1.9×10^{-5} Pa at 25°C (8.25×10^{-8} mm Hg at 20°C) indicates 2,4-D will exist solely in the particulate phase in the ambient atmosphere. Particulate-phase 2,4-D will be removed from the atmosphere by wet and dry deposition. 2,4-D absorbs light in the environmental UV spectrum, and has the potential to undergo direct photolysis.

If released to soil, 2,4-D is expected to have high to very high mobility based upon Koc values ranging from 20 to 136. The pKa of 2.73 for 2,4-D indicates that this compound will primarily exist in anion form in the environment and anions generally do not adsorb to organic carbon and clay more strongly than the non-ionized form. Volatilization from moist soil surfaces is not expected to be an important fate process because anions will not volatilize. Biodegradation is by far the most important loss process for 2,4-D in most soils, leading to various hydroxylic aromatic products. The rate of degradation is affected by the concentration of 2,4-D, temperature, organic matter content of soil, and whether there has been pre-exposure of the soil to 2,4-D, its salts, or esters. Typical half-lives are short, ranging from < one day to several weeks.

If released into water, 2,4-D is not expected to adsorb to suspended solids and sediment based upon the range of Koc values. In water, 2,4-D will biodegrade with the rate dependent upon level of nutrients present, temperature, availability of oxygen, and whether there has been pre-exposure of the water to 2,4-D contamination.

Typical half-lives of 10 to > 50 days have been reported with longer half-lives expected in oligotrophic waters and where a high concentration of 2,4-D is present. Volatilization from water surfaces is not expected to be an important fate process based upon this compound's pKa which indicates 2,4-D will exist almost entirely in the ionized form at pH values of 5 to 9. A BCF of 1 for bluegill sunfish suggests bioconcentration in aquatic organisms is low. Hydrolysis is not expected to occur due to the lack of hydrolyzable functional groups. Half-lives of 2-4 days were reported for 2,4-D photolysis in water solution irradiated at 356 nm.

Occupational exposure to 2,4-D may occur through inhalation of dust and dermal contact with this compound at workplaces where 2,4-D is produced or used. Agricultural and commercial lawn care workers may be exposed to 2,4-D compounds during spraying operations using herbicides containing this chemical. Monitoring data indicate that the general population may be exposed to 2,4-D *via* ingestion of food and drinking water and dermal contact with herbicide products containing 2,4-D.

3.1.3. Toxicology and ecotoxicology

- Acute toxicity: Moderately hazardous (WHO)
- Carcinogenicity : Possible (International Agency for Research on Cancer, IARC)
- Endocrine disruption: in Keith, Colborn, Benbrook, European Union (EU) and Environmental Protection Agency (EPA) Illinois lists
- Reproductive and developmental toxicity: not listed.

Human exposure

The compound, 2,4-D is not cumulative in body tissues. It may be absorbed from the gastrointestinal tract, by inhalation and to a lesser extent by the intact skin. Observations were made on 220 workers exposed to 2,4-D from 0.5 to 22 years in a manufacturing plant. Medical evaluation revealed no difference when compared to a control group of 4600. In the exposed group 10 men were karyotyped. There was no effect on the structural integrity or arrangement of the genetic material of the lymphocyte chromosomes. In another study there were complaints of general weakness, rapid fatigue, frequent headache and vertigo among a number of workers at a plant manufacturing the amine salt and butyl ester. Cases of arterial hypotension were noted. There were possible indications of liver dysfunction which was noted in workers with long exposure to herbicides. In two groups of agricultural workers 250 and 45 respectively, excessive fatigue, epigastric pains, anorexia and occasional respiratory tract symptoms and impaired taste sensitivity were reported. Reported cases of poisoning have been mainly the result of accidental or suicidal ingestion. Peripheral neuropathy has been reported along with contact dermatitis. After oral administration of 2,4-D in a male human subject, 73% of the dose was excreted in the urine in 48 hr.

Animal studies

2,4D may be absorbed by the gastrointestinal tract, by inhalation or through intact skin. Studies in vivo on liver mitochondria have demonstrated that this herbicide uncouples oxidative phosphorylation at low concentrations. After oral administration of (14)C labeled material, only 0.25% of the dose was altered to an unidentified metabolite found in the liver, the remainder was excreted or found in body tissues as unchanged 2,4-D. In rats given various doses of (14)C labeled 2,4-D, 94-99% was excreted in 72 hr and in rats at the high dose levels the compound was excreted in 144 hr. Young female rats were given various doses of 2,4-D orally by stomach tube five times a week for up to four weeks. At the lowest dose in this study there was no adverse response, as determined by gross appearance, hematology or histopathology. At higher doses showed varying degrees of gastrointestinal irritation, slight cloudy swelling of the liver and depressed growth rate. High doses mortality was elevated due to severe gastrointestinal irritation. Accumulation of effect may occur in the form of liver or kidney damage but no clear cut biochemical lesion associated with prolonged exposure. Female rats were fed various levels of 2,4-D in their diet for up to two years. There was no significant difference in mortality between test and control groups. At autopsy of those animals who survived for the two year period there was no difference in body weight and hematological parameters were normal except in the final examination after 22 months revealed a possible tendency to macrocytosis, polychromasia and hypochromasia. Bile duct proliferation, slight hepatitis and nephritis occurred slightly more in test animals rather than controls. 2,4,-D is not considered a carcinogen. In a two-year feeding study in rats there was a slight increase in tumour incidence in female rats observed. However, the results were inconclusive and the raw data did not show enough evidence to determine if 2,4-D is carcinogenic. In a number of experiments in which rats, guinea pigs, hamsters and mice high doses of 2,4-D there appeared to be an increased incidence of minor skeletal abnormalities. 2,4-D had a dose dependent inhibitory effect on cell growth of L929 cells in monolayer cultures. 2,4D essentially affects the kidney, hepatic and nervous systems.

Terrestrial invertebrates

	Acid	Ethylhexyl ester
Acute toxicity to mammals:	469 mg a.s./kg bw	896 mg a.s./kg bw
Acute toxicity to birds:	> 500 mg a.s./kg bw	663 mg a.s./kg bw
Dietary toxicity to birds:	> 5620 mg a.s./kg	> 5620 mg a.s./kg
Reproductive toxicity to birds:	NOEC 1000 ppm	Rapid hydrolysis to the acid form, therefore no risk is anticipated. No further data are required
Short term oral toxicity to mammals:	25 mg/kg bw/d (developmental toxicity rat)	16 mg/kg bw/d (developmental toxicity rat)

Honeybees

Acute oral toxicity:	94 µg/bee	>100 µg/bee
	>100 µg/bee	>100 µg/bee

Other arthropod species

Poecilus cupreus	Mortality: < 30 % (5-6 week old adults; 2.80 kg a.s./ha; BAS 009011H)	No data have been submitted. Hydrolysis to the acid is very rapid in soil (1.5 days and/or 79 minutes) therefore the effect can be diminished under field conditions. At the same time risk mitigation measures are recommended or higher tier testing may be required at MS level
Trichogramma cacoeciae	Inhibition of parasitisation rate: 38.9 % (adults: 0.95 kg a.s./ha; U 46 Combi fluid)	No data have been submitted

Earthworms

	Acid	Ethylhexyl ester
Acute toxicity:	350 mg a.s./kg d. wt. soil	Not required due to rapid hydrolysis to the acid form, with DT_{50} in soil of 1.5 days.
Reproductive toxicity:	Not submitted. Not required	Not required due to rapid hydrolysis to the acid form, with DT_{50} in soil of 1.5 days and DT_{90} < 100 days.

Soil micro-organisms

Nitrogen mineralization:	No adverse effects for up to 10 kg a.s./ha over a period of 28 d in field soil	Not required due to rapid hydrolysis to the acid form, with DT_{50} in soil of 1.5 days
Carbon mineralization:	No adverse effects for up to 10 kg a.s./ha over a period of 28 d in field soil	Not required due to rapid hydrolysis to the acid form, with DT_{50} in soil of 1.5 days

Aquatic organisms

Organisms	Acute toxicity range
Amphibians	Not Acutely Toxic to Slightly Toxic
Annelida	Not Acutely Toxic
Crustaceans	Not Acutely Toxic to Slightly Toxic
Fish	Not Acutely Toxic to Moderate Toxicity
Insects	Not Acutely Toxic to Slightly Toxic
Marine benthic community	Very Highly Toxic
Molluscs	Not Acutely Toxic
Zooplankton	Not Acutely Toxic to Moderate Toxicity

Acute toxicity fish:	LC50 = 100 mg/l (*Pimephales promelas;* 96 h)	LC50 >1.9 mg/l (*Menidia beryllina*; 96 h)
Long term toxicity fish:	32-day NOEC = 63.4 mg/l (*Pimephales promelas*)	The substance has low water solubility, quickly degraded to the acid form, low persistence in natural systems is expected. However from a 32 day embryo-larval test the overall NOEC was 0.12 mg a.s./l (physical effect of the undissolved material
Bioaccumulation fish:	BCF = 10 (3-day fish & algae test)	Not required as DT_{50} in natural water is 6.2 h
Acute toxicity invertebrate:	EC50 = 100 mg/l (*Daphnia magna;* 48 h)	EC50 >1.91 mg/l (*Daphnia magna*; 96 h)
Chronic toxicity invertebrate:	21-day NOEC = 46.2 mg/l (*Daphnia magna*)	The substance has low water solubility, quickly degraded to the acid form, low persistence in natural systems is expected. However a 21 day EC50 was 1.35 mg a.s./l

	Acid	**Ethylhexyl ester**
Acute toxicity algae:	96-hr EC50 = 24.2 mg/l *(Selenastrum capricomutum)*	120-day EC50 = 0.23 mg/l *(Skeletonema constatum)*
Chronic toxicity sediment dwelling organism:	No further data are required due to the low toxicity of the active substances to *Daphnia magna*.	No further data are required due to the low toxicity of the active substances to *Daphnia magna*. The ester is quickly degraded to the acid so chronic exposure is not anticipated
Acute toxicity aquatic plants:	14-day EC50 = 0.58 mg/l; 14-day NOEC = 0.27 mg/l (*Lemna gibba*)	14-day EC50 = 0.50 mg/l (*Lemna gibba*)

	Acid	Ethylhexyl ester
Aphidius rhopalosiphi.	Mortality 7.5% - Reduction in beneficial capacity 13.2% (adults: 3.0 kg a.s./ha; 2,4-D DMA 600 g/l - Desormone liquid) Mortality 0% - Reduction in beneficial capacity - 29.6% (adults: 0.15 (5% drift) kg a.s./ha; 2,4-D DMA 600 g/l - Desormone liquid)	Mortality 100% (at 5% drift 12.5%) – Reduction in beneficial capacity 100% (at 5% drift 23.1%) (adults: 0.564 Kg a.e./ha and 0.0282 kg a.e./ha (5% drift); 2,4-D EHE 572 g/l – Esteron 60)
Aleochara bilineata	Reduction of laying performance and hatchability: No mortality observed in adults (2.80 kg a.s./ha; U 46 Combi fluid)	No data have been submitted. Hydrolysis to the acid is very rapid in soil (1.5 days) therefore the effect can be diminished under field conditions. At the same time risk mitigation measures are recommended or higher tier testing may be required at MS level
Typhlodromus pyri	Mortality 5.3% - Reduction in beneficial capacity 6.2% (protonymphs: 3.0 kg a.s./ha; 2,4-D DMA 600 g/l - Desormone liquid) Mortality 8.5% - Reduction in beneficial capacity 10.3% (protonymphs: 0.15 (5% drift) kg a.s./ha; 2,4-D DMA 600 g/l - Desormone liquid)	Mortality 4.3% (at 5% drift 6.4%)- Reduction in beneficial capacity 20.6% (at 5% drift - 2%) (protonymphs: 0.564 Kg a.e./ha and 0.0282 Kg a.e./ha (5% drift); 2,4-D EHE 572 g/l – Esteron 60)

HC5 = 9139 (4844 – 17444) µg/L derived from animals LC_{50} up to seven days of exposure.

3.1.4. Environmental standards/regulations

Water standards and criteria

U.S. National Drinking Water Standards and Health Criteria		Concentration in µg/L (unless noted)
	Maximum contaminant level (MCL)	70
	Maximum contaminant level goal (MCLG)	70
	1-day Exposure Health Advisory Level	1000
	10-day Exposure Health Advisory Level	300
	Reference dose	5 (µg/kg/day)
	US Drinking Water Equivalent Level	200
WHO Water Quality Criteria		30 (applied to free acid)
Canada water quality guidelines for the protection of aquatic life	Freshwater (for phenoxy herbicides is based on data for ester formulations of 2,4–dicholorophenoxyacetic acid)	4
Australian Drinking Water Guideline		30
	ANZECC trigger value (95% protection level)	280
EU Drinking Water Guidelines		0.1
	Germany - Water Quality Guidelines for the Protection of Aquatic Life	2
	UK — Water Quality Guidelines for the Protection of Aquatic Life	0.3 ($PNEC_{aqua}$)
	France — Water Quality Guidelines for the Protection of Aquatic Life ($AA\text{-}QS_{water\_eco}$)	2.7 (freshwater)
	France — Maximum acceptable concentration	5.8 (freshwater)
	France —Sediment quality guideline (freshwater)	5 µg/kg (dry weight)

Regulations

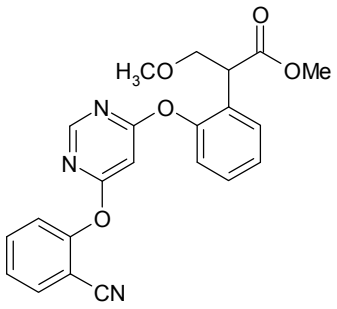
Registered for use in: 29 countries (including AU, EU, US, NZ, SA, India)
Banned in: Norway
The reasons for the final regulatory action were relevant to: Human health and environment
Listed for concern: Groundwater protection list of the Department of Regulation of Pesticides (California) (DPR, CA, 2013).

3.1.5. Important user information

On the basis of the proposed and supported uses, the following particular issues have been identified as requiring particular and short term attention from users as appropriate:

- Leaching to groundwater: Particular attention should be given to the potential for groundwater contamination, when the active substance is applied in regions with vulnerable soil and/or climatic conditions.
- Operator safety: users should pay particular attention to dermal absorption of the active substance under different conditions of use.
- For products containing 2,4-D 2-EHE appropriate risk mitigation measures or higher tier testing may be required to ensure protection of non-target arthropods.

3.2. Azoxystrobin



3.2.1. Physico-chemical properties

Cas number	131860-33-8
Name (IUPAC)	Methyl (2*E*)-2-(2-{[6-(2-cyanophenoxy)pyrimidin-4-yl]oxy}phenyl)-3-methoxyacrylate
Use class	Fungicide
Chemical class	Strobin
Appearance	White crystalline powder, tech. as (962 g/kg) pale brown crystalline powder
Melting point	116°C
Boiling point	above 360°C
Relative density	1.34 g/cm3 (purity: 990 g/kg) at 20°C
Vapour pressure	1.1×10^{-10} Pa at 20°C
Henry's law constant	7.3×10^{-9} Pa at 20°C
Solubility in water	pH 5.2: 6.7 mg/L at 20°C
	pH 7.0: 6.7 mg/L at 20°C
	pH 9.2: 5.9 mg/L at 20°C
Solubility (g/L) in organic solvents (at 20°C)	Hexane: 0.057
	Octan-1-ol: 1.4
	Methanol: 20
	Toluene: 55
	Acetone: 86
	Ethyl acetate: 130
	Acetonitrile: 340
	Dichloromethane: 400
Partition coefficient (log Kow)	2.76
Adsorption coefficient (Koc)	589

Hydrolytic stability (DT_{50})	25°C, pH 5-9: stable
	50°C, pH 5-7: stable
	50°C, pH 9: 12.1 d,
	60°C, pH 9: 2.6 d
Photostability in water (DT_{50})	8.7 - 13.9 d at pH 7
Aerobic soil half-life	113 d
Anaerobic soil half-life	119 d

3.2.2. Environmental fate

The production of azoxystrobin may result in its release to the environment through various waste streams and its use as a fungicide will result in its direct release to the environment.

If released to air, a vapour pressure of 1.1×10^{-10} Pa at 20°C indicates azoxystrobin will exist solely in the particulate phase in the atmosphere. Particulate-phase azoxystrobin will be removed from the atmosphere by wet or dry deposition.

If released to soil, azoxystrobin is expected to have moderate to low mobility based upon Log Koc values of 2.31 to 2.77. Volatilization from moist soil surfaces is not expected to be an important fate process based upon an estimated Henry's Law constant. Azoxystrobin was present at 22.3 and 60.9% of applied dose (100 mg/kg) to compost aged for 3 and 12 months, respectively, in 125-day tests, suggesting that biodegradation is not an important environmental fate process in soil.

If released into water, azoxystrobin is expected to adsorb to suspended solids and sediment based upon the log Koc values. In the dark and under aerobic conditions, the half-life of azoxystrobin was in the range of eight to 12 weeks. Volatilization from water surfaces is not expected to be an important fate process based upon this compound's estimated Henry's Law constant. An estimated bioconcentration factor (BCF) of 21 suggests the potential for bioconcentration in aquatic organisms is low. Azoxystrobin has been experimentally shown to be stable to hydrolysis at pH 5 and 7; at pH 9 a half-life of 12.1 days is reported.

Occupational exposure to azoxystrobin may occur through inhalation of dust and dermal contact with this compound at workplaces where azoxystrobin is produced or used. Monitoring data indicate that the general population may be exposed to azoxystrobin *via* ingestion of food containing residual and dermal contact in places azoxystrobin is used.

3.2.3. Toxicology and ecotoxicology

- Acute toxicity: unlikely (WHO)
- Carcinogenicity: not likely
- Endocrine disruption: not listed.

Terrestrial organisms

Acute toxicity to mammals:	LD_{50} > 5000 mg as/kg bw
Acute toxicity to birds:	LD_{50} > 1000 mg as/kg bw
Dietary toxicity to birds:	LC_{50} > 5200 ppm as
Reproductive toxicity to birds:	NOEC 1200 ppm as
Short term oral toxicity to mammals	NOAEL 500 ppm as

Effect after proposed conditions of use:

Typhlodromus pyri	***low to medium risk, i.e. acceptable impact (SC, WG)***
Amblyseius aberrans	***low to medium risk, i.e. acceptable impact (SC, WG)***

Earthworms

Acute toxicity	LC_{50} = 283 mg as/kg dry wt substrate
Reproductive toxicity:	NOEC 3.0 kg as/ha (250 SC)

Soil micro-organisms

Nitrogen mineralization	No effect up to 2.5 kg ***as***/ha (250 SC)
Carbon mineralization:	No effect up to 2.5 kg ***as***/ha (250 SC)

Honeybees

Acute oral toxicity	LD_{50} > 25 µg as/bee, 24 h study
Acute contact toxicity	LD_{50} > 200 µg as/bee, 24 h study

Other arthropod species

Acute and short-term toxicity:

Aphidius rhopalosiphi	23 % effect **(*sublethal*)** at 0.25 kg as/ha (250 SC)
Trichogramma cacoeciae	***1.8 %*** effect at 0.15 kg as/ha (500 WG)
Typhlodromus pyri	3.9 % effect at 0.1875 kg as/ha (500 WG)
Typhlodromus pyri	6.9 % effect at 0.1875 kg as/ha (250 SC)
Episyrphus balteatus	*48 % effect **(sublethal)** at 0.25 kg as/ha (250 SC)*
Poecilus cupreus	0 % effect at 0.25 kg as/ha (250 SC)

Aquatic organisms

Organisms	Acute toxicity range
Fish	Slight to High Toxicity
Zooplankton	High to Very High Toxicity

Acute toxicity fish	LC_{50} (Rainbow trout) = 0.47 mg as/L, 96 h study
Acute toxicity invertebrate	EC_{50} (*Macrocyclops fuscus*) = 0.13 mg as/L, 48 h study LC_{50} (*Daphnia magna*) = 0.071 mg/L, 48 h study
Acute toxicity algae	EC_{50} (*Selenastrum capric.*) = 0.36 mg as/L, 96 h study
Chronic toxicity algae	NOEC (*Selenastrum capric.*) = 0.038 mg/L 96h study
Chronic toxicity sediment dwelling organism	NOEC 0.8 mg as/L
Chronic toxicity invertebrates	NOEL (*Daphnia magna*) = 0.000026 mg/L, 21 d

HC5 = 77 (66 – 90) µg/L, derived from LC_{50} with aquatic animals exposed up to four days.

3.2.4. Environmental standards/regulations

Water standards and criteria

EU Drinking Water Guideline		0.1 µg/L
	Germany - Water Quality Guidelines for the Protection of Aquatic Life	2 µg/L
	UK - Water Quality Guidelines for the Protection of Aquatic Life	0.3 µg/L ($PNEC_{aqua}$)
	France - Water Quality Guidelines for the Protection of Aquatic Life ($AA\text{-}QS_{water\_eco}$)	0.95 µg/L (freshwater)
	France – Maximum acceptable concentration	0.55 µg/L (freshwater)
	France – Sediment quality guideline (freshwater)	1.6 µg/kg (dry weight)
	France – PNEC	3 µg/L

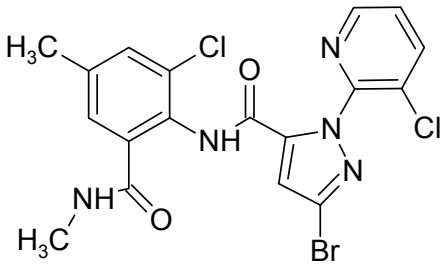
Regulations

Registered for use in: 17 countries (including, AU, CA, EU, NZ, US, SA)
Listed for concern: Groundwater Protection List of Department of Pesticide Regulation (DPR, CA, 2013).

3.2.5. Important user information

On the basis of the proposed and supported uses, attention should be given to the impact on aquatic organisms. Risk mitigation measures should be applied where appropriate.

3.3. Chlorantraniliprole (Calteryx)



3.3.1. Physico-chemical properties

Cas number	500008-45-7
Name (IUPAC)	3-bromo-N-[4-chloro-2-methyl-6-(methylcarbamoyl)phenyl]-1-(3-chloropyridin-2-yl)-1H-pyrazole-5-carboxamide
Use class	Insecticide
Chemical class	Anthranilic diamide
Appearance	Fine, crystalline, off-white powder
Melting point	208 - 210°C
Relative density	1.1589 (95.9%), 1.507 (99.2%) at 20°C
Vapour pressure	1.599×10^{-12} Pa at 25°C (est)
Henry's law constant	1.42×10^{-16} $Pa.m^3$/mole
Solubility in water	0.9 – 1 mg/L at 20°C, pH 7
Solubility (g/L) in organic solvents (at 20°C)	acetone: 3.4 acetonitrile: 0.71 methanol: 1.71
Dissociation constant (pKa)	10.88
Partition coefficient (log Kow)	2.76
Adsorption coefficient (Koc)	244 - 464
Hydrolytic stability (DT_{50})	30 d
Aerobic soil half-life	523 d
Anaerobic soil half-life	184 d

3.3.2. Environmental fate

The production of chlorantraniliprole may result in its release to the environment through various waste streams and its use as an insecticide will result in its direct release to the environment.

If released to air, an estimated vapour pressure of 1.599×10^{-12} Pa at 25°C indicates chlorantraniliprole will exist solely in the particulate phase in the atmosphere. Particulate-phase chlorantraniliprole will be removed from the atmosphere by wet or dry deposition.

If released to soil, chlorantraniliprole is expected to have moderate mobility based upon Koc values of 244 to 464. Volatilization from moist soil surfaces is not expected to be an important fate process based upon an estimated Henry's Law constant of 1.42×10^{-16} $Pa.m^3$/mole. Chlorantraniliprole has an environmental half-life of <2 to 12 months with shorter half-lives occurring with crop cover. This degradation is mostly abiotic.

If released into water, chlorantraniliprole is expected to adsorb to suspended solids and sediment based upon the Koc values. Volatilization from water surfaces is not expected to be an important fate process based upon this compound's estimated Henry's Law constant. An estimated BCF of 31 suggests the potential for bioconcentration in aquatic organisms is moderate.

Chlorantraniliprole is stable to hydrolysis in the environment up to pH 9, at which point it has a half-life of 10 days. Occupational exposure to chlorantraniliprole may occur through inhalation and dermal contact with this compound at workplaces where chlorantraniliprole is produced or used.

3.3.3. Toxicology and ecotoxicology

- Acute toxicity: not listed
- Carcinogenicity: not likely (EPA)
- Endocrine disruption: not listed

Terrestrial organisms

Mammals - Acute oral LD_{50} (mg/kg)	> 5000	Rat	Low
Birds - Acute LD_{50} (mg/kg)	> 2250	*Colinus virginianus*	Low
Birds - Short term dietary (LC_{50}/LD_{50}) mg/kgbw/day	> 1729	*Colinus virginianus*	-
Honeybees - Acute 48 hour LD_{50} (µg bee^{-1})	> 4	Contact	Moderate
Earthworms - Acute 14 day LC_{50} (mg/kg)	632.5	*Eisenia fetida*	
Earthworms - Chronic 14 day NOEC, reproduction (mg/kg)	350	*Eisenia fetida*	Low
Other arthropod (1) LR_{50} g ha^{-1}	>750	*Aphidius rhopalosiphi*	Harmless at 1 kg/ha
Other arthropod (2) LR_{50} g ha^{-1}	>750	*Typhlodromus pyri*	Harmless at 1 kg/ha
Other arthropod (3) – chronic reproduction 21 days - EC_{50} (mg/kg soil (dry weight))	0.48	*Folsomia candida*	
Soil micro-organisms	Nitrogen mineralisation: No significant effect Carbon mineralisation: No significant effect	Dose: 0.7 mg/kg soil, 28 days	-

Aquatic organisms

While non-definitive LC_{50} values are only available for chlorantraniliprole, it can be characterized as being slightly toxic to practically non-toxic to both freshwater and estuarine/marine fish. However, it can be characterized as very highly toxic to freshwater and certain estuarine marine invertebrates. This is based on the data for the eastern oyster. Because the most sensitive species acutely (oyster) is not represented by chronic values, the acute to chronic ratio for the mysid (1.15/0.695 = 1.65) was applied to the oyster LC_{50} to estimate a chronic effects endpoint for this species (0.0399 mg/L/1.65 = 0.024 mg/L). The available data show no indications that formulated products are more toxic than the active ingredient (EPA 2008).

Fish - Acute 96 hour LC_{50} (mg L^{-1})	> 12.0	*Cyprinodon variegatus*	Moderate
Aquatic invertebrates - Acute 48 hour EC_{50} ($mg.L^{-1}$)	0.0116	*Daphnia magna*	High
Aquatic invertebrates - Chronic 21 day NOEC ($mg.L^{-1}$)	0.00447	*Daphnia magna*	

Sediment dwelling organisms - Chronic 28 day NOEC, static, water ($mg.L^{-1}$)	0.0025	unknown species	High
Aquatic plants - Acute 7 day EC_{50}, biomass ($mg.L^{-1}$)	> 2.0	*Lemna gibba*	Moderate
Algae - Acute 72 hour EC_{50}, growth ($mg.L^{-1}$)	> 4.0	*Pseudokirchneriella subcapitata*	Moderate

3.3.4. Environmental standards/regulations

Water standards and criteria

Australian Drinking Water Guideline: 6000 µg/L

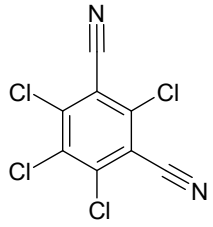
Regulations

Registered for use in: 10 countries (including AU, NZ, US) approval pending in EU.

3.3.5. Important user information

N/A

3.4. Chlorothalonil



3.4.1. Physico-chemical properties

Cas number	1897-45-6
Name (IUPAC)	Tetrachloroisophthalonitrile
Use class	Fungicide
Chemical class	Substituted benzene
Appearance	white crystalline solid or powder
Melting point	252°C
Boiling point	> 350 °C
Relative density	1.735 (99.8%)
Vapour pressure	7.62×10^{-5} Pa at 25°C
Henry's law constant	2.5×10^{-2} Pa.m^3/mole at 25°C
Solubility in water	0.81 - 1 mg/L at 25°C (neutral pH)
Solubility (g/L) in organic solvents (at 20°C)	acetone: 20.6 dichloroethane: 22.4 ethyl acetate: 13.8 n-heptane: 0.2 xylene: 74.4 methanol: 1.36
Partition coefficient (log Kow)	2.94 at 25°C
Adorption coefficient (Koc)	1790
Hydrolytic stability (DT_{50})	pH 5: stable pH 7 : stable pH 9 : 16-38 d
Photostability in water (DT_{50})	At pH 5 and 25 °C is 64.7 days with 12 hours sunlight/day
Aerobic soil half-life	35 d
Anaerobic soil half-life	8 d

3.4.2. Environmental fate

The production of chlorothalonil may result in its release to the environment through various waste streams and its use as a broad spectrum, non-systemic protectant pesticide will result in its direct release to the environment. Chlorothalonil is primarily used as a fungicide to control fungal foliar diseases of vegetable, field, and ornamental crops. It is also used as a wood protectant, antimold and antimildew agent, bactericide, microbiocide, algaecide, insecticide, and acaricide.

If released to air, a vapour pressure of 7.62×10^{-5} Pa at 25°C indicates chlorothalonil will exist in both the vapour and particulate phases in the ambient atmosphere. Vapour-phase chlorothalonil will be degraded slowly in the atmosphere by reaction with photochemically-produced hydroxyl radicals; the half-life for this reaction in air is estimated to be 7 years. Direct photolysis may also occur, however the rate of this reaction in the atmosphere is not known. Particulate-phase chlorothalonil will be removed from the atmosphere by wet and dry deposition.

If released to soil, chlorothalonil is expected to have low mobility or be immobile, based on Koc values in the range of 900 to 7,000 measured in four soils. Volatilization from moist soil surfaces is not expected to be important based upon a Henry's Law constant of 2.5×10^{-2} Pa.m^3/mole at 25°C. Volatilization from dry soil surfaces is not expected to be an important environmental fate process based on the vapour pressure of chlorothalonil. Aerobic biodegradation half-lives of chlorothalonil in four different soils ranged from 10 to 40 days.

If released into water, chlorothalonil is expected to adsorb to suspended solids and sediment in the water column based upon the Koc data. Volatilization from water surfaces is not expected to be an important fate process based upon this compound's Henry's Law constant. Biodegradation is expected to be an important fate process given aerobic aquatic degradation half-lives of 8.1 and 8.8 days measured in marine water, and anaerobic degradation half-lives ranging from 5-15 days measured in flooded soils. Hydrolysis does not occur under acidic conditions or at pH 7; however a hydrolysis half-life of 38.1 days was observed for chlorothalonil at pH 9. An aqueous photolysis half-life of 65 days was measured for chlorothalonil, suggesting photolysis in sunlit surface waters is possible. BCF values of 9.4 to 264 measured in different species of fish, suggest bioconcentration in aquatic organisms can be low to high.

Occupational exposure to chlorothalonil may occur through inhalation of dusts or dermal contact with this compound at workplaces where it is produced or used as a pesticide. The greatest potential for dermal and inhalation exposure to chlorothalonil is expected for pesticide applicators and farm workers that have frequent contact with products containing this compound. Monitoring data indicate that the general

population may be exposed to chlorothalonil *via* inhalation of ambient air and ingestion of food.

3.4.3. Toxicology and ecotoxicology

- Carcinogenicity: Possible (2B) IARC, likely (EPA)
- Endocrine disruption: not listed.

Terrestrial organisms

Acute toxicity to mammals:	chlorothalonil LD50 >5000 mg/kg bw SDS-3701 LD50 242 mg/kg bw
Acute toxicity to birds:	chlorothalonil LD50 >2000 mg/kg bw SDS-3701 LD50 158 mg/kg bw
Dietary toxicity to birds:	chlorothalonil LC50 >5200 mg/kg fd SDS-3701 LC50 1780 mg/kg fd
Reproductive toxicity to birds:	chlorothalonil NOEC 160 mg/kg fd SDS-3701 NOEC 50 mg/kg fd
Long term toxicity to mammals:	chlorothalonil NOEC 330 mg/kg fd (developmental NOAEL) SDS-3701 NOEC 30 mg/kg fd (reproductive NOAEL (decreased body weight pups))

Honeybees

Acute oral toxicity:	>40 µg/bee
Acute contact toxicity:	>63 µg/bee

Other arthropod species

Laboratory tests				
type Dosage	crop type	species tested	Bravo 500 2.2 [l/ha]	Bravo 720SC [kg a.i./ha] Dosage a: 0.173 Dosage b: 6.0 Dosage c: 7.7 Dosage d: 10.5
Predacious mite	base set	Typhlodromus pyri		Dosage b: moderately harmful (94% effect)
Aphid parasitoide	base set	Aphidius rhopalosiphi Aphidius spp.		Dosage a, b and c: slightly harmful (41-62% effect)
ground dwelling predator		Aleochara bilineata or Poecilus cupreus	harmless	Dosage d: harmless
leaf dwelling predator		Chrysoperla carnea		Dosage c: harmless
Extended laboratory tests				
Predacious mite		Typhlodromus pyri		Dosage (kg as/ha) Mortality (%) Fecundity* 1.50 0 5.0 1.88 0 4.6 5.63 9 3.8 12.0 17 4.4 18.75 13 3.1 control 8.6 There were significant effects on fecundity at every dose, so the NOER < 1.50 kg as/ha. * mean number of eggs per female (7 – 14 DAT)
Aphid parasitoide		Aphidius rhopalosiphi		Dosage (kg as/ha) Mortality (%) 4.33 20 7.70 20 18.75 44 No effects on fecundity at dosages up to 7.70 kg as/ha (at 18.75 kg as/ha fecundity is not assessed)

Earthworms

Acute toxicity:	chlorothalonil: LC50 268.5 mg/kg (at 5% o.m.) SDS-3701: LC50 585 mg/kg R417888: LC50 >1000 mg/kg SDS-46851: LC50 > 1000 mg/kg
Reproductive toxicity:	chlorothalonil: NOEC 25 mg/kg (at 5% o.m.) Chlorothalonil 500 g/L SC: NOEC 1.65 mg as/kg (at 5% o.m.)* SDS-3701: NOEC 25 mg/kg R417888: NOEC 100 mg/kg

* endpoint based on a study from Vischim carried out with the formulation

Aquatic organisms

Organisms	Acute toxicity range
Amphibians	Highly Toxic
Crustaceans	High to Very High Toxicity
Fish	High to Very High Toxicity
Insects	Moderate Toxicity
Molluscs	Slight to Moderate Toxicity
Phytoplankton	Very Highly Toxic
Zooplankton	Slight to Very High Toxicity

Acute toxicity

Species	time	effect	value mg a.i./L	
Oncorhynchus mykiss		LC50	0.038	geometric mean
Lepomis macrochirus		LC50	0.052	geometric mean
Cyprinus carpio		LC50	0.076	geometric mean
Ictalurus punctatus	96 hours	LC50	0.047	
Cyprinodon variegatus	96 hours	LC50	0.033	
Galaxias maculatus	96 hours	LC50	0.016	
Galaxias truttaceus	96 hours	LC50	0.0189	
Galaxias auratus	96 hours	LC50	0.0292	
Pimephales promelas	96 hours	LC50	0.023	
Gasterosteus aculeatus	96 hours	LC50	0.027	
Leiostomus xanthurus	48 hours	LC50	0.032	
Daphnia magna		EC50	0.084	geometric mean
Bracionus calyciflorus	24 hours	EC50	0.024	
Leptocerus	48 hours	EC50	0.038	
Crangonyx pseudogracillis	48 hours	EC50	0.064	
Chydorus	48 hours	EC50	0.074	
Crassostrea virginica	96 hours	EC50	0.011	geometric mean
Lymnea stagnalis	48 hours	EC50	0.26	
Planorbis	48 hours	EC50	0.12	
Erpobdella	48 hours	EC50	0.16	
Planaria	48 hours	EC50	0.2	
Macrocyclops fuscus	48 hours	EC50	0.26	
Gammarus pulex	48 hours	EC50	0.24	
Hyalella azteca	48 hours	EC50	0.25	

Species	time	effect	value mg a.i./L	
Chironomus riparius		EC50	0.061	geometric mean
Ostracoda	48 hours	EC50	0.39	
Asellus aquaticus	48 hours	EC50	0.45	
Cloeon dipterum	48 hours	EC50	0.6	
Ischnura elegans	48 hours	EC50	0.56	
Penaeus duorarum		LC50	0.228	geometric mean
Parataya australiensis	96 hours	LC50	0.016	
Astacopsis gouldi	96 hours	LC50	0.012	
Selenastrum capricornutum		EC50	0.116	geometric mean
Scenedesmus subspicatus	96 hours	EbC50	0.31	
Navicula pelliculosa	120 hours	EbC50	0.0096	
Anabaena flos-aquae	120 hours	EbC50	0.074	
Sensitivity distribution		HC5 95% cf	0.01 (0.005-0.016)	of L(E)C50 values
Mean of the log toxicity values	-1.1382			
Sample standard deviation	0.5219			
Sample size	36			

Long term toxicity

Species	time	effect	value in mg a.i./L	
Pimephales promelas	2-generation	NOEC	0.003	
Oncorhynchus mykiss	21 days	NOEC	0.003	geometric mean
Navicula pelliculosa	120 hours	NOEC	0.0035	
Daphnia magna	21 days	NOEC	0.0085	geometric mean
Scenedesmus subspicatus	96h	NOEC	0.020	geometric mean
Anabaena flos-aquae	120 hours	NOEC	0.020	
Selenastrum capricornutum	72-96h	NOEC	0.033	geometric mean
Chironomus riparius	28 days	NOEC	0.040	
Lemna gibba	14 days	NOEC	0.29	
Sensitivity distribution	normal distribution	HC5 (95% cf)	0.001 (0.0002-0.003)	of NOEC values
Mean of the log toxicity values	1.1792			
Sample standard deviation	0.6540			
Sample size	9			

- the average HC5 for the L(E)C50 is 0.01 mg/l (n=36); the average HC5 for the NOECs is 1 µg/l (n=9)
- The number of acute samples vs. chronic samples (36 vs 9) and the spread of the HC5 estimates indicates that the acute HC5 is statistically the more reliable value. Given the rapid dissipation in the aquatic systems, chronic exposure due to the agricultural applications is considered less likely. The initial PEC is the protective estimation for the acute effects, because many toxicity data are based on nominal concentrations and because it cannot be excluded that

pronounced effects may appear already after a short-term exposure.

Outdoor microcosm study (without fish) • On basis of the most sensitive endpoints studied the overall NOEC in the microcosms is 10 µg chlorothalonil/L; • In shallow freshwater ecosystems an EAC of 30 µg chlorothalonil/L may allow sustainable populations of sensitive algae and invertebrates, since recovery of affected populations of algae and invertebrates was observed a few weeks after the last application.

Bioconcentration

Bioconcentration factor (BCF)	2300 l/kg based on r.a. In the fish BCF study r.a. in fish consisted of large number of components, only two were >10% of applied (whole fish based): di- and triglutathione conjugates, 18% and 12% of total r.a. residue. Metabolite SDS-3701 was detected as a minor component, and no unmetabolised chlorothalonil was detected. The BCF for chlorothalonil is estimated <100 l/kg.
Annex VI Trigger for the bioconcentration factor	100
Clearance time (CT_{50}) (CT_{90})	2-7 days for r.a.

Protection levels derived from LC_{50} with freshwater animals:

- 95% (HC5): 1.65 (0.3 – 9.3) µg/L
- 80%: 16.8 (3.1 – 89.4) µg/L

3.4.4. Environmental standards/regulations

Water standards and criteria

U.S. National Drinking Water Standards and Health Criteria		Concentrations in µg/L (unless noted)
	Maximum contaminant level (MCL)	0
	One Day Exposure Health Advisory Level	200
	Ten Day Exposure Health Advisory Level	200
	Lifetime Exposure Health Advisory Level	
	Reference dose	15 (µg/kg/day)
	U.S. Drinking Water Equivalent Level	500
	Concentration with lifetime cancer risk of 1 in 10000	150

Canada Water Standards and Criteria		
Canada Water Quality Guidelines for the Protection of Aquatic Life	Freshwater	0.18
	Saltwater	0.36
Canada Water Quality Guidelines for the Protection of Agricultural Water uses	Irrigation	5.8 (interim)
	Livestock	170 (interim)
Australian Drinking Water Guideline		50
France - PNEC		1

Regulations

Registered for use in: 17 countries (including AU, EU, US, NZ, SA)
Listed for concern: Groundwater Protection List of Department of Pesticide Regulation (DPR, CA, 2013).

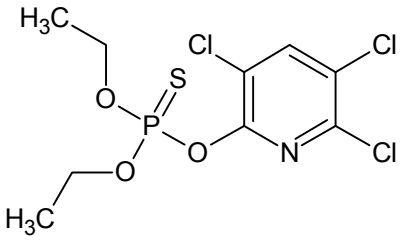
3.4.5. Important user information

On the basis of the proposed and supported uses, the following particular issues have been identified as requiring particular and short term attention from users as appropriate. Particular attention should be given to:

- the impact on aquatic organisms.
- groundwater, in particular with regards to the active substance and its metabolites when the substance is applied in regions with vulnerable soil and/or climate conditions.

Risk mitigation measures should be applied where appropriate.

3.5. Chlorpyrifos



3.5.1. Physico-chemical properties

Cas number	2921-88-2
Name (IUPAC)	O,O-diethyl-O-3,5,6-trichloro-2-pyridyl phosphorothioate
Use class	Insecticide, nematicide
Chemical class	Organophosphorus
Appearance	Tan, crystallyne solid. Munsell colour notation 2.5Y 7/4
Melting point	41-42°C
Boiling point	Decomposes before boiling. Thermal decomposition 170-180ºC
Relative density	1.51
Vapour pressure	3.35×10^{-3} Pa at 25°C (99.8 %) 1.43×10^{-3} Pa at 20°C (99.8%)
Henry's law constant	0.478 $Pa.m^3$ /mole
Solubility in water	1.05 mg/L at 20ºC in unbuffered solution
Solubility in organic solvents (in g/L at 20°C)	Hexane 774 (99.9 %) Toluene: >4000 (99.9 %) Dichloromethane: >4000 (99.9 %) Methanol: 290 (99.9 %) Acetone: >4000 (99.9 %) Ethyl acetate: >4000 (99.9 %) Hexane 774 (99.9 %) Toluene: >4000 (99.9 %)
Partition coefficient (log Kow)	4.7
Adsorption coefficient (Koc)	995 - 31000
Hydrolytic stability (DT_{50})	pH ≤ 7: 62d (25°C) pH 9: 16d (25°C)
Photostability in water (DT_{50})	39.9 days (natural river water under natural sunlight)

	29.6 days (pH 7, natural sunlight)
Aerobic soil half-life	30.5 d

3.5.2. Environmental fate

The production of chlorpyrifos may result in its release to the environment through various waste streams and its use as an insecticide will result in its direct release to the environment. If released to air, a vapour pressure of 3.35×10^{-3} Pa at 25°C indicates chlorpyrifos will exist in both the vapour and particulate phases in the atmosphere. Vapour-phase chlorpyrifos will be degraded in the atmosphere by reaction with photochemically-produced hydroxyl radicals; the half-life for this reaction in air is estimated to be 4.2 hours. Particulate-phase chlorpyrifos will be removed from the atmosphere by wet or dry deposition. Chlorpyrifos absorbs light greater than 295 nm and photolysis has been observed in air. The photodegradation half-life of a thin film of chlorpyrifos on a glass plate exposed to environmentally significant wavelengths from a UV light was reported to be 52.45 hours.
If released to soil, chlorpyrifos is expected to have low to no mobility based upon measured Koc values of 995 to 31,000. Volatilization from moist soil surfaces may be an important fate process based upon a Henry's Law constant of 0.478 $Pa.m^3$ /mole. The volatilization half-life of chlorpyrifos from 3 moist soils was in the range of 45-163 hours using an airstream of 1 km/hr passed over the soil. Chlorpyrifos is not expected to volatilize from dry soil surfaces based upon its vapour pressure. In soil, chlorpyrifos had a half-life of 33 to 56 days for soil-incorporated applications and 7-15 days for soil surface applications. Half-lives of one week (sandy loam) and 2.5 weeks (organic) in non-sterile soils versus half-life of 17 and 40 weeks, respectively, in the sterilized soils.

If released into water, chlorpyrifos is expected to adsorb to suspended solids and sediment based upon the Koc. Chlorpyrifos degraded about 40% faster in active (natural) water as compared to the same water which had been sterilized with formalin. The reported half-life in active water was 24.5 days. Volatilization from water surfaces is expected to be an important fate process based upon this compound's Henry's Law constant. Estimated volatilization half-lives for a model river and model lake are 24 and 178 days, respectively. However, volatilization from water surfaces is expected to be attenuated by adsorption to suspended solids and sediment in the water column. Measured BCF values of 58 to 1,000 suggest bioconcentration in aquatic organisms is moderate to high. The hydrolysis half-life of chlorpyrifos in distilled water at 25°C was reported as 62 days (pH 4.7), 35 days (pH 6.9) and 22 days (pH 8.1).

Occupational exposure to chlorpyrifos may occur through inhalation and dermal contact with this compound at workplaces where chlorpyrifos is produced or used. Monitoring and use data indicate that the general population may be exposed to

chlorpyrifos via inhalation of ambient air, ingestion of food and drinking water, and dermal contact with this compound.

3.5.3. Toxicology and ecotoxicology

- Carcinogenicity: unlikely (EPA)
- Endocrine disruption: in Keith, Colborn and EU lists

Terrestrial organisms

Acute toxicity to mammals:	Mouse (females) LD50= 64 mg/kg b.w.
Acute toxicity to birds:	Active substance: *Passer domesticus* 122 mg as/kg *Coturnix coturnix* LD50 = 13.3 mg/kg bw 95th percentile of the Species Sensitivity Distribution, 6.9 mg as/kg bw Formulated: *Phasianus colchicus* LD50 =8.41 mg/kg b. w.
Dietary toxicity to birds:	Mallard duck LC50= 203 ppm (a value of 180 was obtained in another study not fully validable)
Reproductive toxicity to birds:	Mallard duck NOEC = 25 ppm
Short term oral toxicity to mammals:	Rat 2 generations NOAEL = 1 mg/kg bw/day

Honeybees

Acute oral toxicity:	0.25 µg/bee
Acute contact toxicity:	0.059 µg/bee

Other arthropod species

Test species	Stage	Test Substance	Dose (kg as/ha)	Endpoint	Effect
Aleochara bilineata	adults	Dursban	960g ai/ha	parasitisms	100%
Typhlodromus pyri	protonymphs	EC formulation	576g ai/ha	Beneficial capacity	100%
Aphidius rhopalosiphi		EC formulation	576g ai/ha	Beneficial capacity	100%
Poecilus cupreus		EC formulation	576g ai/ha	Beneficial capacity	100%

Species tested / Stage	**Dose (g as/ha)**	**Initial effects**	**Persistence**	**Notes**
Laboratory tests				
Typhlodromus pyri protonymphs	Dose-response	LC_{50} 1986 ppm	-	Dip test
Aphidius colemani Adults	Dose-response	LC_{50} *ca.* 1 ppm Equivalent to 0.2 g as/ha	-	Glass plate
Coccinella septempunctata Larvae	Dose-response	LC_{50} 33.4 ppm Equivalent to 66.8 g as/ha	-	Glass plate
Poecilus cupreus	Dose-response	LC_{50} 224 ppm	-	Topical application
Extended laboratory				
Typhlodromus pyri Protonymphs	317 48	M = 0%, R = 0% M = 6%, R = 0%	-	Bean leaves
Aphidius rhopalosiphi Adults	317 48	M = 100% M = 100%	M = 0%, 7 days M = 2.9%, 7 days No effect on parasitism	Bean leaves
Chrysoperla carnea Larvae	317 48	M = 100% M = 89%	M = 21%, 7 days M = 1%, 7 days	Bean leaves

Species tested / Stage	Dose (g as/ha)	Initial effects	Persistence	Notes
			No effects on fecundity	
Chrysoperla carnea Larvae	1000 g as/hL	M = 100%	M = 0%, 14 days	Field aged residues in apple laboratory bioassay. 10x field conc. tested
Extended laboratory / semi-field				
Aphidius colemani (pupae within mummified aphids)	120 480	M = 17% M = 55%	-	Field aged residues in winter wheat laboratory bioassay
Aphidius colemani Adults	120 480	100% 100%	M = 0%, 8 days M = 10%, 14 days	Field aged residues in winter wheat laboratory bioassay
Coccinella septempunctata	120 480	M = 28% M = 98%	M = 13%, 2 days	Field aged residues in winter wheat laboratory bioassay
Bembidion lampros Adults On LUFA soil	0.12 0.48	M = 100% M = 100%	M = 15%, 5 days M = 70%, 9 days	Field aged soil in winter wheat laboratory bioassay
Bembidion lampros Adults On field soil	120 480	M = 100% M = 100%	M = 5%, 5 days M =100%, 9 days	Field aged soil in winter wheat laboratory bioassay
Pardosa spp. Adults	120 480	M = 10% M = 55%	- M = 15%, 2 days	Field aged soil in winter wheat laboratory bioassay
Field studies **Orchard test in France 1991 (J63).** One summer application at 960 g as/ha, conducted to GLP. Initial reduction in				

abundance observed for *Heterotoma planicornis*, Heteroptera, hymenoptera, *Chilochorus bispustulatus*, Coccinellidae, *Forficula*, spiders and Diptera. Recovery observed for most taxa 11 to 25 days after treatment.

Grassland test in UK 1992 (J78).
One spring application 720 g as/ha, conducted to GLP. After application Staphylinidae and Carabidae species were initially reduced in numbers but showed signs of recovery within the first year. Collembola were strongly affected after application with numbers depressed throughout the year. Linyphiidae were initially affected after a spring applications, but rapidly recovered in the summer. Lycosidae were unaffected. By the spring of the following year all affected taxa had recovered.

Vines field test in France 1996 non-GLP (Spinosad MJ27)
A single late season application of chlorpyrifos at 336 g as/ha in vines caused a temporary reduction in mite numbers of 36% up to 9 days after application. By 38 days the population had recovered to levels similar to that of the control.

Earthworms

Acute toxicity:	14days LC50 =129 mg/kg Metabolite TCP 14 days LC50 =9.8 mg/kg Formulated product: 138 mg as/kg
Reproductive toxicity:	56 days NOEC = 9.5 kg chlorpyrifos/ha (12.7 mg as/kg) Metabolite TCP 56-day NOEC 4.60 mg/kg dry soil

Soil micro-organisms

Nitrogen mineralization:	No significant effects at 4.8 kg a.i./ha
Carbon mineralization:	No significant effects at 4.8 kg a.i./ha

Aquatic organisms

Organisms	Acute toxicity range
Amphibians	Moderate to Very High Toxicity
Annelida	Very Highly Toxic
Crustaceans	High to Very High Toxicity
Fish	Moderate to Very High Toxicity
Insects	Moderate to Very High Toxicity
Marine benthic community	Very Highly Toxic
Molluscs	Moderate to High Toxicity

Nematodes and flatworms	Moderate to Very High Toxicity
Phytoplankton	Moderate Toxicity
Zooplankton	Slight to Very High Toxicity

	Test substance	Time-scale	Endpoint	Toxicity (mg/l)
Acute toxicity fish:	technical	acute	96h LC50 (10 species) (5 species)	 0.0013-520 0.00054-203
Long term toxicity fish:	technical	chronic	35d NOEC ELS	0.00014
	Metabolite TCP	chronic	31d NOEC	0.0808
Bioaccumulation fish:	No data	No data	No data	No data
Acute toxicity invertebrate:	formulated technical	acute	48h EC50	0.000014a.i. 0.0001
Chronic toxicity invertebrate:	Technical formulated	chronic	35 days NOEC M.bahia 21 days NOEC D.magna	0.0046 0.000056
Acute toxicity algae:	Technical formulated	Acute chronic	72h EC50 NOEC NOEC	1.2 0.1-0.001 0.027-0.063
Microcosm or mesocosm tests	Several studies. Predicted No Effects Concentrationor EAC of 0.1 µg /l.			

HC5 = 0.15 (0.07 – 0.324) µg/L from LC_{50} of aquatic animals exposed up to 10 days.

3.5.4. Environmental standards/regulations

Water standards and criteria

U.S. National Drinking Water Standards and Health Criteria		**Concentrations (µg/L)**
	Maximum contaminant level (MCL)	0
	One Day Exposure Health Advisory Level	30
	Ten Day Exposure Health Advisory Level	30
	Lifetime Exposure Health Advisory Level	2
	U.S. Drinking Water Equivalent Level	10
	WHO Water Quality Criteria	30 µg/L

Canada Standards and Criteria		
Drinking water	Maximum acceptable concentration (MAC)	90
Canada Water Quality Guidelines for the Protection of Aquatic Life	Freshwater	0.0035
	Saltwater	0.002
Canada Water Quality Guidelines for the Protection of Agricultural Water uses	Livestock	24 (interim)
Australian Drinking Water Guideline		**10 µg/L**
French Water Guidelines		
France - Water Quality Guidelines for the Protection of Aquatic Life	(AA-QS_{water_eco} / PNEC)	0.33 µg/L (freshwater)
France – Environmental quality guideline		0.03 µg/L

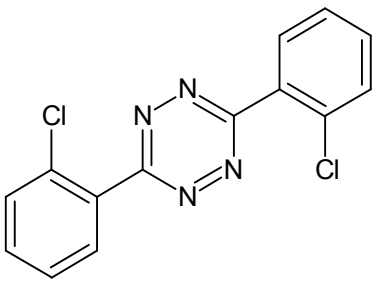
Regulations

Registered for use in: 28 countries (including AU, CA, NZ, EU, US, India)
Banned in: Saudi Arabia
Reasons for the final regulatory action were relevant to: Human health
Listed for concern: EU-WFD list of priority substances.

3.5.5. Important user information

Users should pay particular attention to the protection of birds and mammals, aquatic organisms, bees and non-target arthropods and must ensure that the conditions of authorisation include, where appropriate, risk mitigation measures.

3.6. Clofentezine



3.6.1. Physico-chemical properties

Cas number	74115-24-5
Name (IUPAC)	3,6-bis(o-chlorophenyl)-1,2,4,5-tetrazine
Use class	Insecticide
Chemical class	Tetrazine
Appearance	Magenta crystals
Melting point	182 - 185°C
Boiling point	504.36°C
Vapour pressure	6.0×10^{-7} Pa at 20 °C 1.4×10^{-6} Pa at 25 °C 6.1×10^{-5} Pa at 50 °C
Henry's law constant	0.168 Pa·m³/mol
Solubility in water	< 2 µg/L pH7
Relative density	1.5
Solubility (g/L) in organic solvents (at 25°C)	Acetone: 9.3 Dichloromethane: 37.4 Ethanol: 0.49 DMSO: 11.8
Partition coefficient (log Kow)	3.1
Hydrolytic stability (DT_{50})	pH 9: DT_{50}< 0.1 days pH7: DT_{50}= 1.1 d at 35°C
Photolysis (DT_{50})	7 d (pH 7)
Aerobic soil half life	6.7 – 131.1 d

3.6.2. Environmental fate

The vapour pressure at 25°C was extrapolated using Clapeyron-Clausius analysis and found to be 1.4×10^{-7} Pa. This result indicates that clofentezine is unlikely to

dissipate in the environment by volatilization. The octanol/water partition coefficient for clofentezine was reported to be 1353 (log Kow = 3.1). The accuracy of this value is questionable since it was based on measured concentrations of clofentezine in the aqueous phase which were well above the solubility limit in water. Clofentezine was found to be essentially insoluble in water. The results of various determinations indicated that the solubility of clofentezine in water is < 40 ppb. Clofentezine will undergo base-catalyzed hydrolysis. The half-lives for hydrolysis were reported to be approximately four hours at pH 9, 34 hours at pH 7 and 249 hours (10 days) at pH 5. Because of various difficulties in conducting hydrolysis studies due to the low water solubility, the accuracy of these half-lives is uncertain. However, it can be concluded from all the evidence provided that hydrolysis of clofentezine occurs fairly rapidly at environmentally relevant pH values. Phototransformation studies indicated that clofentezine can undergo phototransformation quite readily in water, but is relatively stable to light on a soil surface. Biotransformation studies showed that clofentezine residues will dissipate in soil by binding, by biotransformation and, most probably, by hydrolysis.

Under aerobic soil conditions in the laboratory, the DT_{50} for clofentezine ranged from 4 to 8 weeks at 22°C and 9 to 14 weeks at 15°C. Under anaerobic conditions (flooded soil), clofentezine appeared to be more readily bound to soil and less readily transformed than under aerobic conditions. Mineralization of clofentezine residues to CO_2 proceeded rapidly in aerobic soils, but ceased when soils were flooded. Studies with sterilized soils indicated that complete mineralization of clofentezine residues required full microbial activity and that non-biotic processes (*e.g*. hydrolysis) may be important in the transformation of clofentezine in soil. Studies conducted in the laboratory with freshly collected sediment/water samples indicated that clofentezine will partition readily into sediments and will be readily transformed. The DT_{50s} of extractable clofentezine residues from both sediment and water in these samples were < 7 days. In biotransformation studies no transformation products were observed that were both major and persistent. However, in aqueous phototransformation studies conducted under sterile conditions, the transformation product 2-chlorobenzonitrile was observed to accumulate, accounting for 75% of the recovered radioactivity by the end of a 31-day sunlight exposure period. In dark controls, this transformation product also accumulated over the study period, but accounted for a maximum concentration of only 6% by the end of the study. On a soil surface treated with 14C-clofentezine, 2-chlorobenzonitrile accounted for 5.5% of the applied radioactivity after exposure sunlight over a period of 31 days. In hydrolysis studies, 2-chlorobenzonitrile was observed in samples taken at approximately 1.5 half-lives for clofentezine hydrolysis and accounted for approximately 6% of the recovered radioactivity. In non-sterile, aerobic soil samples and in sediment/water microcosms incubated in the dark, 2-chlorobenzonitrile was not observed, which may indicate that the compound is rapidly biodegraded, strongly adsorbed, or formed only in undetectable quantities.

Under field conditions in both Canada and the United Kingdom, clofentezine was seen to be non-persistent to moderately persistent in soil, with DT_{50s} ranging between 19 and 73 days. In soil surface litter in a B.C. orchard, clofentezine -16-appeared to be non-persistent following an early season application. However, some additional information concerning experimental design was necessary to substantiate these observations and to define the scope of the submitted information. The results indicate the clofentezine should dissipate fairly rapidly in orchard litter following the proposed single early-season applications. The results of both laboratory and field studies indicated that clofentezine will not leach through soil.

3.6.3. Toxicology and ecotoxicology

- Carcinogenicity: Possible human carcinogen (EPA).
- Endocrine disruption : EU and Colborn list.

Terrestrial organisms

Mammals - Acute oral LD_{50} (mg/kg)		> 5200	A5 Rat	Low
Mammals - Short term dietary NOEL		40	(ppm diet) L2 Rat, 2 year	-
Birds - Acute LD_{50} (mg/kg)		> 3000	*Anas platyrhynchos*	Low
Birds - Short term dietary (LC_{50}/LD_{50})		> 4000 mg kg bw^{-1} day^{-1}	*Anas platyrhynchos*	
Honeybees - Acute 48 hour LD_{50} (µg bee^{-1})		> 84.5	Contact	Moderate
Earthworms - Acute 14 day LC_{50} (mg/kg)		> 215	*Eisenia fetida*, corr	Moderate
Earthworms - Chronic 14 day NOEC, reproduction (mg/kg)		2.7	*Eisenia fetida*	Moderate
Other soil macro-organisms - *e.g.* Collembola mg/kgsoil		> 160	*Folsomia candida*, NOEC	-
Other arthropod (1)	LR_{50} g/ha	36.2	*Aphidius rhopalosiphi*	Harmful at 1 kg/ha
	% Effect	25	Mortality Dose: 0.3 g/ha *Aphidius rhopalosiphi*	Harmless

Other arthropod (2)	LR_{50} g/ha	300	Mortality *Typhlodromus pyri*	Harmful at 1 kg/ha
	% Effect	0	Mortality Dose: 0.3 g/ha *Typhlodromus pyri*	Harmless
Soil micro-organisms		Nitrogen mineralisation: No significant effect Carbon mineralisation: No significant effect	Dose: 4.0 L formulation/ha, 28days	

Aquatic organisms

Organism group	Acute toxicity range
Fish	Slight to Moderate Toxicity
Zooplankton	Slight Toxicity

Fish - Acute 96 hour LC_{50} (mg/L)	> 0.015	*Oncorhynchus mykiss*	High
Fish - Chronic 21 day NOEC (mg/L)	0.007	*Oncorhynchus mykiss*, 97 days	-
Aquatic invertebrates - Acute 48 hour EC_{50} (mg/L)	> 0.0008	*Daphnia magna*	High
Aquatic invertebrates - Chronic 21 day NOEC (mg/L)	0.025	*Daphnia magna*	-
Sediment dwelling organisms - Chronic 28 day NOEC, static, water (mg/L)	0.5	*Chironomus riparius*	Moderate
Algae - Acute 72 hour EC_{50}, growth (mg/L)	0.32	*Pseudokirchneriella subcapitata*	Moderate

Clofentezine is of low toxicity to earthworms, soil microorganisms, honey bees, and indicator species of fish and aquatic invertebrates. Clofentezine was stimulatory to algae at low concentrations, possibly by acting as a source of nitrogen. No algal growth inhibition was observed. The bioconcentration factor for clofentezine in bluegill sunfish was reported to be 430. The depuration of residues from the fish was rapid with 88% being eliminated after three days from the cessation of exposure. The submitted information indicated that clofentezine would not be directly toxic to the following beneficial predators and parasites, some of which are important in integrated pest management in orchards: *Tyhlodromus occidentalis, Phytoseilus persimilis*. The safety of clofentezine *to Typhlodromus pyriwas* was also shown, however, there was some evidence which suggested a low level of mortality in eggs and nymphs of this

predator for seven days after being sprayed with solution containing 300 ppm clofentezine under field conditions.

HC5 = 10.37 µg/L (95% CI n/a) derived from LC_{50} of animals exposed up to four days. This value is unreliable due to the low number of species used.

3.6.4. Environmental standards/regulations

Regulations
Registered for use in: 25 countries (including, AU, CA, EU, NZ, SA, US).

3.6.5. Important user information

On the basis of the proposed and supported uses, the following particular issues have been identified as requiring particular and short term attention from users, as appropriate:

- the specification of the technical material as commercially manufactured must be confirmed and supported by appropriate analytical data. The test material used in the toxicity dossiers should be compared and verified against this specification of the technical material
- the operator and worker safety and ensure that conditions of use prescribe the application of adequate personal protective equipment where appropriate
- the potential for long range transport *via* air
- the risk to non-target organisms. Conditions of authorisation shall include risk mitigation measures, where appropriate

3.7. Copper hydroxide

3.7.1. Physico-chemical properties

Cas number	20427-59-2
Name (IUPAC)	Copper hydroxide
Use class	Fungicide, microbiocide, nematicide
Chemical class	Inorganic - copper
Appearance	Blue-green solid
Vapour pressure	1×10^{-6} Pa
Solubility in water	0.506 mg/L
Relative density	3.37
Solubility (mg/L) in organic solvents (at 25°C)	acetone: 0.005 heptane: 0.007
Adsorption coefficient (Koc)	12000
Partition coefficient (log Kow)	0.44
Hydrolytic stability (DT_{50})	stable

3.7.2. Toxicology and ecotoxicology

- Acute toxicity: slightly hazardous (WHO)
- Carcinogenicity: not listed
- Endocrine disruption: not listed
- Reproductive and Developmental Toxicity: not listed.

Terrestrial organisms

Mammals - Acute oral LD_{50} (mg/kg)	> 489	Rat	Moderate
Birds - Acute LD50 (mg/kg)	223	*Colinus virginianus*	Moderate
Honeybees - Acute 48 hour LD_{50} (µg bee^{-1})	44.5	Contact	Moderate
Earthworms - Acute 14 day LC_{50} (mg/kg)	> 677	*Eisenia fetida*	Moderate
Earthworms - Chronic 14 day NOEC, reproduction (mg/kg)	< 15	*Eisenia fetida*, as Cu 8 weeks	Moderate
Other arthropod (1) LR_{50} (g/ha)	0.05	As Cu *Aphidius rhopalosiphi*	Harmful at 1 kg/ha
Other arthropod (2) LR_{50} (g/ha)	14.9	As Cu *Typhlodromus pyri*	Harmful at 1 kg/ha

Soil micro-organisms	Nitrogen mineralisation: No significant effect Carbon mineralisation: No significant effect	Dose: 12.5 kg Cu/ha	-

Aquatic organisms

Organism group	Acute toxicity range
Fish	High toxicity
Crustaceans	Not Acutely Toxic
Molluscs	Moderate to High Toxicity

Fish - Acute 96 hour LC_{50} (mg/L)	0.017	*Oncorhynchus mykiss*	High
Aquatic invertebrates - Acute 48 hour EC50 (mg/L)	0.038	*Daphnia magna*	High
Aquatic invertebrates - Chronic 21 day NOEC (mg/L)	0.03	*Daphnia magna*	
Algae - Acute 72 hour EC_{50}, growth (mg/L)	0.009	*Pseudokirchneriella subcapitata*	High

The HC5 = 3.15 (1.8 – 4.7) µg/L

3.7.3. Environmental standards/regulations

U.S. National Drinking Water Standards and Health Criteria		1000 µg/L (copper)
WHO Water Quality Criteria		2000 µg/L
Canada Drinking Water Standards and Criteria		Concentrations (µg/L)
	Maximum acceptable concentration (MAC)	500
Canada Water Quality Guidelines for the Protection of Aquatic Life	Freshwater	2 (variable)
	Marine	3
Canada Water Quality Guidelines for the Protection of Agricultural Water uses	Livestock	200 (variable)
	Irrigation	300

ANZECC Guidelines		
	Freshwater	1.4
	Marine	1.3
EU – Drinking Water Guideline		2000 µg/L
France - Water Quality Guidelines for the Protection of Soil and Aquatic Life	PNEC soil	2.4 mg/kg (dry weight)
	PNEC freshwater	1.6 µg/L
	PNEC sediment freshwater	0.8 mg/kg (dry weight)
	PNEC marine	0.8 µg/L

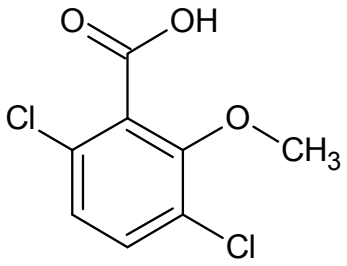
Regulations

Registered for use in: 16 countries (including, AU, CA, NZ, SA, US).

3.7.4. Important user information

N/A

3.8. Dicamba



(Other forms: Dicamba with 2,4D, Dicamba with 2,4-D & Silvex, Dicamba aluminium salt, Dicamba aminopropylmorpholine salt, Dicamba butoxyethyl ester, Dicamba diethanolamine salt, Dicamba diglycolamine salt, Dicamba dimethylamine salt, Dicamba isopropylamine salt, Dicamba methyl ester, Dicamba monoethanolamine salt, Dicamba potassium salt, Dicamba sodium salt, Dicamba triethanolamine salt)

3.8.1. Physico-chemical properties

Cas number	1918-00-9
Name (IUPAC)	3,6-dichloro-o-anisic acid
Use class	Herbicide
Chemical class	Benzoic acid
Melting point	115°C
Vapour pressure	1.66×10^{-3} Pa at 25°C
Henry's law constant	1×10^{-4} Pa.m^3/mole
Solubility in water	27200 mg/L
Solubility (g/L) in organic solvents (at 20°C)	acetone: 500 hexane: 2.8 methanol: 500
Partition coefficient (log Kow)	-1.88
Adsorption coefficient (Koc)	7 - 34
Hydrolytic stability (DT_{50})	30 d
Photostability in water (DT_{50})	50 d
Aerobic soil half-life	10 d
Anaerobic soil half-life	58 - 141 d

3.8.2. Environmental fate

The production of dicamba may result in its release to the environment through various waste streams and its use as a registered herbicide for post emergent control

of broadleaf weeds and woody plants will result in its direct release to the environment.

If released to air, a vapour pressure of 1.66×10^{-3} Pa at 25°C indicates dicamba will exist in both the vapour and particulate phases in the atmosphere. Vapour-phase dicamba will be degraded in the atmosphere by reaction with photochemically-produced hydroxyl radicals; the half-life for this reaction in air is estimated to be 5.4 days. Particulate-phase dicamba will be removed from the atmosphere by wet or dry deposition. A loss of 41% following continuous exposure of a natural water solution of dicamba to an artificial UV light (320 nm) for 133 days suggests that dicamba may be susceptible to direct photolysis in the atmosphere by sunlight.

If released to soil, dicamba is expected to have very high mobility based upon experimentally-determined Koc values of 7 to 34. Literature reviews of dicamba adsorption and leaching in soil indicate the herbicide is highly mobile in most soil types. The pKa of dicamba is 1.97, indicating that this compound will exist almost entirely in the anion form in the environment and anions generally do not adsorb more strongly to soils containing organic carbon and clay than their neutral counterparts. Volatilization of dicamba from soil surfaces is not expected to be an important fate process; over a 154-day observation period, 0.6-7.9% of soil-applied dicamba volatilized. Although dicamba may leach readily in soil, the importance of leaching and volatilization can be attenuated by rapid aerobic biodegradation; microbial degradation is the most important process controlling the fate of dicamba in soil. Aerobic soil metabolism is the main degradative process with the formation of 3,6-dichlorosalicylic acid; metabolism in anaerobic soil is similar to aerobic soil (*e.g.* formation of 3,6-dichlorosalicylic acid) but slower. The persistence of dicamba in agricultural soils is highly variable and depends on factors such as application rates, moisture content, temperature, pH, soil type. Typical field dissipation half-lives can vary from 4.4 to 50 days under aerobic conditions with 18 days being an approximate median half-life. Under conditions amenable to rapid metabolism, the half-life is <14 days. Under anaerobic conditions, soil half-lives of 58 to 141 days have been observed.

If released into water, dicamba is not expected to adsorb to suspended solids and sediment based upon the Koc values. Microbial degradation appears to be the most important removal process in natural water. In non-sterile water, 16% of applied dicamba disappeared after 133 days, suggesting that biodegradation in water may be an important environmental fate process. Dicamba did not bioaccumulate in algae, clam, crab, daphnia, elodea, mosquito fish, mosquito larvae or snail over a 32-day test period in an aquatic ecosystem study, indicating that bioconcentration in aquatic organisms is low (BCF of 15). Dicamba is stable to abiotic hydrolysis in water and photodegrades slowly in water.

Occupational exposure to dicamba may occur through inhalation and dermal contact with this compound at workplaces where dicamba produced or used (*e.g.* mixing,

loading, or applying dicamba or by entering a previously treated site). Monitoring data indicate that the general population may be exposed to dicamba *via* inhalation of ambient air, ingestion of food and drinking water, and dermal contact with this compound.

3.8.3. Toxicology and ecotoxicology

- Acute toxicity : slightly hazardous (WHO)
- Carcinogenicity: unclassifiable (inadequate data) (EPA)
- Endocrine disruption: not listed
- Reproductive and developmental toxicity: listed in US TRI Developmental toxin.

Terrestrial organisms

Mammals - Acute oral LD_{50} (mg/kg)	1581	Rat	Moderate
Mammals - Short term dietary NOEL (mg kg^{-1})	> 110	Rat, 2 year	Moderate
Birds - Acute LD_{50} (mg/kg)	1373	*Anas platyrhynchos*	Moderate
Birds - Short term dietary (LC_{50}/LD_{50})	> 10000 mg kg $feed^{-1}$	*Anas platyrhynchos*	
Honeybees - Acute 48 hour LD_{50} (µgbee^{-1})	> 100	Oral	Moderate
Earthworms - Acute 14 day LC_{50} (mg/kg)	> 1000	*Eisenia fetida*	Moderate
Other arthropod (1) LR_{50} (g/ha)	28.9	Reproductive effect *Typhlodromus pyri*	Harmful at 1 kg/ha
Other arthropod (2) LR_{50} (g/ha)	356	Fecundity *Aphidius rhopalosiphi*	Harmful at 1 kg/ha
Soil micro-organisms	Nitrogen mineralisation: No significant effect Carbon mineralisation: No significant effect	Dose: 6.4 mg/kg soil, 28 days	-

Aquatic organisms

Organism group	Acute toxicity range
Amphibians	Not Acutely Toxic
Crustaceans	Not Acutely Toxic
Fish	Not Acutely Toxic to Slightly Toxic
Zooplankton	Not Acutely Toxic to Moderate Toxicity

Fish - Acute 96 hour LC_{50} (mg/L)	> 100	*Oncorhynchus mykiss*	Moderate
Fish - Chronic 21 day NOEC (mg/L)	180	*Oncorhynchus mykiss*	-
Aquatic invertebrates - Acute 48 hour EC_{50} (mg/L)	> 41.0	*Daphnia magna*	Moderate
Aquatic invertebrates - Chronic 21 day NOEC (mg/L)	97	*Daphnia magna*	-
Aquatic crustaceans - Acute 96 hour LC_{50} (mg/L)	6.8	*Mysidopsis bahia*	Moderate
Aquatic plants - Acute 7 day EC_{50}, biomass (mg/L)	0.45	*Lemna minor*	Moderate
Algae - Acute 72 hour EC_{50}, growth (mg/L)	1.8	*Skeletonema costatum*, Biomass	Moderate
Algae - Chronic 96 hour NOEC, growth (mg/L)	25	Unknown species	Low

HC5 = 2898 (741 – 11326) µg/L derived from LC_{50} of aquatic animals exposed up to four days.

3.8.4. Environmental standards/regulations

Water standards and criteria

U.S. National Drinking Water Standards and Health Criteria		Concentrations (µg/L)
	Maximum contaminant level (MCL)	0
	Lifetime Exposure Health Advisory Level	4000
	U.S. Drinking Water Equivalent Level	18000
WHO Water Quality Criteria		30
Canada Standards and Criteria		
Drinking water	Maximum acceptable concentration (MAC)	120
Canada Water Quality Guidelines for the Protection of Aquatic Life	Freshwater	10
Canada Water Quality Guidelines for the Protection of Agricultural Water uses	Irrigation	0.006
	Livestock	122
Australian Drinking Water Guideline		100
France - PNEC		45

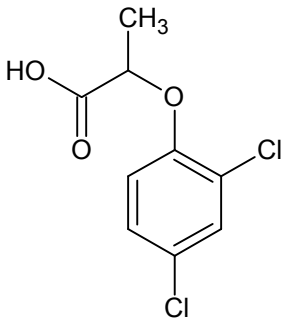
Regulations

Registered for use in: 15 countries (including, AU, CA, EU, NZ, SA, US)
Listed for concern: Groundwater Protection List of Department of Pesticide Regulation (DPR, CA, 2013).

3.8.5. Important user information

N/A

3.9. Dichlorprop



(Other forms: 2,4-DP isooctyl ester, 2,4-DP triethanolamine salt, 2,4-DP 2-ethylhexyl ester, 2,4-DP-P dimethylamine salt, 2,4-DP-P isooctyl ester, 2-(2,4-DP) dimethylamine salt, Dichlorprop butoxyethyl ester, Dichlorprop-P, Dichlorprop-P potassium salt, Dichlorprop-P sodium salt)

3.9.1. Physico-chemical properties

Cas number	120-36-5 or 7547-66-2 (used by WHO)
Name (IUPAC)	(RS)-2-(2,4-dichlorophenoxy)propionic acid
Use class	herbicide
Chemical class	Chlorophenoxy acid or ester
Appearance	White to tan crystalline solid
Melting point	117.5°C
Relative density	1.42
Vapour pressure	1×10^{-5} Pa at 25°C
Henry's law constant	8.8×10^{-6} Pa.m^3/mole at 25°C
Dissociation constant (pKa)	3.1
Solubility in water	350 mg/L
Solubility (g/L) in organic solvents (at 20°C)	acetone: 595 isopropanol: 510 ethanol: >100
Partition coefficient (log Kow)	2.29 - 3.43
Adsorption coefficient (Koc)	34 - 129
Hydrolytic stability (DT_{50})	stable
Aerobic soil half-life	10 – 14 d

3.9.2. Environmental fate

The production of dichlorprop may result in its release to the environment through various waste streams and its use as a herbicide will result in its direct release to the environment.

If released to air, a vapour pressure of 1×10-5 Pa at 25°C indicates dichlorprop will exist in both the vapour and particulate phases in the atmosphere. Vapour-phase dichlorprop will be degraded in the atmosphere by reaction with photochemically-produced hydroxyl radicals; the half-life for this reaction in air is estimated to be 34 hours. Particulate-phase dichlorprop will be removed from the atmosphere by wet or dry deposition. Dichlorprop contains chromophores that absorb at wavelengths >290 nm and therefore may be susceptible to direct photolysis by sunlight.

If released to soil, dichlorprop is expected to have very high to high mobility based upon Koc values of 34-129. The pKa of dichlorprop is 3.1, indicating that this compound will exist almost entirely in anion form in the environment and anions generally do not adsorb more strongly to soils containing organic carbon and clay than their neutral counterparts. Volatilization from moist soil surfaces is not expected to be an important fate process because anions do not volatilize. Biodegradation of dichlorprop in soil has been measured to be from no degradation in 28 days to a half-life of four days. Dichlorprop has been shown to photodegrade on soil surfaces and in aquatic environments.

If released into water, dichlorprop is expected to adsorb to suspended solids and sediment based upon the Koc values. Several aquatic aerobic studies have reported degradation of dichlorprop in 5 months or less. The pKa indicates that dichlorprop will exist almost entirely in the anion form at pH values of 5 to 9 and therefore, volatilization from water surfaces is not expected to be an important fate process. An estimated BCF of 3 suggests the potential for bioconcentration in aquatic organisms is low. Hydrolysis is not expected to be an important environmental fate process since this compound lacks functional groups that hydrolyze under environmental conditions. Occupational exposure to dichlorprop may occur through inhalation and dermal contact with this compound at workplaces where dichlorprop is produced or used. Monitoring data indicate that the general population may be exposed to dichlorprop *via* inhalation and dermal contact with this compound when using this herbicide.

3.9.3. Toxicology and ecotoxicology

- Acute toxicity: slightly hazardous (WHO), slightly toxic (EPA)
- Carcinogenicity: possible (IARC)
- Endocrine disruption: not listed
- Reproductive and developmental toxicity: listed in US Tri Developmental Toxin.

Terrestrial organisms

Mammals - Acute oral LD_{50} (mg/kg)	825	Rat	Moderate
Mammals - Short term dietary NOEL (ppm diet)	5	Rat	-
Birds - Acute LD_{50} (mg/kg)	504	*Coturnix japonica*	Moderate
Honeybees - Acute 48 hour LD_{50} (µg bee^{-1})	16	Contact	Moderate
Earthworms - Acute 14 day LC_{50} (mg/kg)	1000		Moderate

Aquatic organisms

Organism group	Acute toxicity range
Amphibians	Not Acutely Toxic
Fish	Not Acutely Toxic to Moderate Toxicity

Fish - Acute 96 hour LC_{50} (mg/L)	0.5	*Oncorhynchus mykiss*	Moderate
Aquatic invertebrates - Acute 48 hour EC_{50} (mg/L)	100	*Daphnia magna*	Moderate
Algae - Acute 72 hour EC_{50}, growth (mg/L)	1100	*Pseudokirchneriella subcapitata*	Low
Algae - Chronic 96 hour NOEC, growth (mg/L)	180	Unknown species	Low

HC5 = 118 (0.729 – 19098) µg/L derived from LC_{50} of freshwater fish exposed up to four days.

3.9.4. Environmental standards/regulations

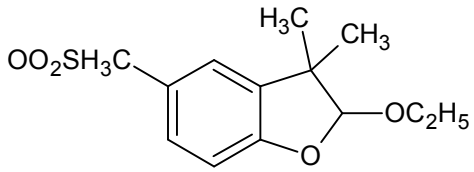
Water standards and criteria

WHO Water Quality Criteria	100 µg/L
Australian Drinking Water Guideline	100 µg/L

Regulations

Registered for use in: Two countries (SA, AU) but not approved in EU or US.

3.10. Ethofemusate



3.10.1. Physico-chemical properties

Cas number	26225-79-6
Name (IUPAC)	(±)-2-ethoxy-2,3-dihydro-3,3-dimethylbenzofuran-5-ylmethanesulfonate
Use class	herbicide
Chemical class	unclassified
Appearance	White crystalline solid
Relative density	1.3
Vapour pressure	6.5 x 10^{-4} Pa (25 °C)
Henry's law constant	6.8 x 10^{-4} Pa.m^3 mol^{-1} (25 °C)
Solubility in water	pH 3 - 11: 39 - 44 mg/L (20 ± 0.5°C)
	pH 7.7: 50 mg/L (25 ± 0.5 °C)
	pH 7.7: 57 mg/L (30 ± 0.1 °C)
Solubility (g/L) in organic solvents (at 25°C)	acetone, dichloromethane, dimethylsulphoxide, ethyl acetate: > 600 g/L
	toluene and p-xylene: 300-600 g/L
	methanol: 120-150 g/L
Partition coefficient (log Kow)	2.7
Adsorption coefficient (Koc)	187.3
Hydrolytic stability (DT_{50})	pH 5 (35 °C, 36 d): 2.68% of NC 8493 were detected after 36 d. Half-life is 940 d. Ethofumesate is stable to hydrolysis. pH 5 (25 °C, 36 d): 1.57% of NC 8493 were detected after 36 d. Half-life is 2050 d. Ethofumesate is stable to hydrolysis. pH 7 (35 °C, 36 d): stable to hydrolysis pH 9 (25 °C, 36 d): stable to hydrolysis
Photostability in water (DT_{50})	8 - 13 d: 12 h of sunlight exposure per day; extrapolated to environmental conditions results in 37 – 62 d: during summer at 40°N to 60°N in Europe 4.6 d: whole year - central Europe 2.6 d: month May - central Europe
Aerobic soil half-life	93 d

3.10.2. Environmental fate

The production of ethofumesate may result in its release to the environment through various waste streams and its use as an herbicide will result in its direct release to the environment.

If released to air, a vapour pressure of 6.5 x 10^{-4} Pa (25 °C) indicates ethofumesate will exist in both the vapour and particulate phases in the ambient atmosphere. Vapour-phase ethofumesate will be degraded in the atmosphere by reaction with photochemically-produced hydroxyl radicals; the half-life for this reaction in air is estimated to be 7 hours. Particulate-phase ethofumesate will be removed from the atmosphere by wet and dry deposition. Ethofumesate absorbs light greater than 290 nm and may be susceptible to direct photolysis in the atmosphere.

If released to soil, ethofumesate is expected to have moderate to high mobility based upon Koc values ranging from 55 to 500, measured in 10 different soils. Volatilization from moist soil surfaces is not expected to be an important fate process based upon an estimated Henry's Law constant of 6.8 x 10^{-4} $Pa.m^3$ mol^{-1}. Ethofumesate is not expected to volatilize from dry soil surfaces based upon its vapour pressure. The biodegradation half-life of ethofumesate in soils under aerobic conditions was reported to range from 83 to 253 days. Direct photolysis on soil surfaces is expected to be an important fate process based on a half-life of 165 hours.

If released into water, ethofumesate is expected to adsorb to suspended solids and sediment based upon the Koc data. Volatilization from water surfaces is not expected to be an important environmental fate process given the estimated Henry's Law constant. Ethofumesate is stable to hydrolysis at pH 5, 7, and 9. The photolysis half-life of ethofumesate in aqueous solutions ranged from 28 to 31 hours, suggesting photolysis in sunlit surface waters will be important. An estimated BCF of 24 suggests the potential for bioconcentration in aquatic organisms is low.
Occupational exposure to ethofumesate may occur through inhalation and dermal contact with this compound at workplaces where ethofumesate is produced or used. The general public will be exposed to ethofumesate *via* dermal contact or through ingestion of contaminated drinking water.

3.10.3. Toxicology and ecotoxicology

- Acute toxicity: unlikely to be hazardous (WHO), slightly toxic (EPA)
- Carcinogenicity: unclassifiable, inadequate data (EPA)
- Endocrine disruption: not listed.

Terrestrial organisms

Mammals - Acute oral LD_{50} (mg/kg)	> 5000	Rat	Low
Mammals - Short term dietary NOEL (ppm diet)	300	Rabbit	-
Birds - Acute LD_{50} (mg/kg)	> 2000	*Anas platyrhynchos*	Moderate
Birds - Short term dietary (LC_{50}/LD_{50})	> 5200 mg kg feed^{-1}	*Anas platyrhynchos*	
Honeybees - Acute 48 hour LD_{50} (µg bee^{-1})	> 50	Oral	Moderate
Earthworms - Acute 14 day LC_{50} (mg/kg)	134	*Eisenia fetida*	Moderate
Earthworms - Chronic 14 day NOEC, reproduction (mg/kg)	> 25	*Eisenia fetida*	Moderate
Soil micro-organisms	Nitrogen mineralisation: -28% Effect Carbon mineralisation: Slight effect	Dose: 2.0 mg/kg soil, 14 days	

Aquatic organisms

Fish - Acute 96 hour LC_{50} (mg/L)	11	*Cyprinus carpio*	Moderate
Fish - Chronic 21 day NOEC (mg/L)	0.8	*Oncorhynchus mykiss*	-
Aquatic invertebrates - Acute 48 hour EC_{50} (mg/L)	14	*Daphnia magna*	Moderate
Aquatic invertebrates - Chronic 21 day NOEC (mg/L)	0.32	*Daphnia magna*	-
Aquatic crustaceans - Acute 96 hour LC_{50} (mg/L)	4.5	*Americamysis bahia*	Moderate
Sediment dwelling organisms - Chronic 28 day NOEC, static, water (mg/L)	5.0	*Chironomus riparius*	Moderate
Aquatic plants - Acute 7 day EC_{50}, biomass (mg/L)	> 50	*Lemna minor*	Low
Algae - Acute 72 hour EC_{50}, growth (mg/L)	3.9	*Raphidocelis subcapitata*	Moderate
Algae - Chronic 96 hour NOEC, growth (mg/L)	6.7	*Scenedesmus subspicatus*	Low

HC5 = 4683 (338 – 64842) µg/L derived from LC_{50} of freshwater fish exposed up to four days.

3.10.4. Environmental standards/regulations

Water standards and criteria
France – PNEC: 32 µg/L

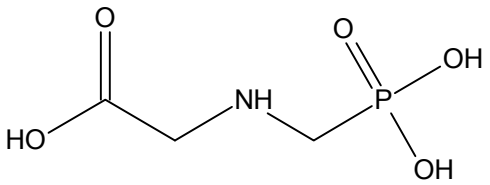
Regulations
Registered for use in: 12 countries (including, US, EU, CA, NZ, and AU)
Listed for concern: Groundwater Protection List of Department of Pesticide Regulation (DPR, CA, 2013).

3.10.5. Important user information

On the basis of the proposed and supported uses, the following particular issue has been identified as requiring particular and short term attention from users as appropriate:

- Leaching to groundwater: Particular attention should be given to the potential for groundwater contamination, when the active substance is applied in regions with vulnerable soil and/or climate conditions and risk mitigation measures should be applied where appropriate.

3.11. Glyphosate



3.11.1. Physico-chemical properties

Cas number	1071-83-6
Name (IUPAC)	N-(phosphonomethyl)-glycin
Use class	herbicide
Chemical class	Phosphonoglycine
Appearance	colourless crystals
Vapour pressure	$1.31 \cdot 10^{-5}$ Pa (25 °C, acid)
Henry's law constant	$2.1 \cdot 10^{-7}$ Pa $\cdot m^3 \cdot mol^{-1}$
Solubility in water	pH 2: 10.5 ± 0.2 g/L (20 °C, 995 g/kg)
Solubility (g/L) in organic solvents (at 25°C)	acetone: 0.078 dichloromethane: 0.233 ethyl acetate: 0.012 hexane: 0.026 methanol: 0.231 n-octanol: 0.020 toluene: 0.036
Dissociation constants (pKa)	2.34 (20 °C), 5.73 (20 °C),10.2 (25 °C)
Partition coefficient (log Kow)	pH 5-9: 3.2 at 25°C
Adsorption coefficient (Koc)	2600 - 4900
Hydrolytic stability (DT_{50})	pH 5, 7 and 9: stable at 25°C
Photostability in water (DT_{50})	33 d (pH 5), 69 d (pH 7), 77 d (pH 9) (Xenon lamp)
Aerobic soil half-life	96 d
Anaerobic soil half-life	22 d

3.11.2. Environmental fate

The production of glyphosate may result in its release to the environment through various waste streams and its use as a broad spectrum non-selective, post-emergent herbicide, will result in its direct release to the environment.

If released to air a vapour pressure of 1.31 $\times 10^{-5}$ Pa (25°C) indicates that glyphosate will exist solely in the particulate-phase in the ambient atmosphere. Particulate-phase glyphosate will be removed from the atmosphere by wet and dry deposition.

If released to soil, glyphosate is expected to have slight mobility, based on Koc values in the range of 2,600 to 4,900. Volatilization from moist soil surfaces is not expected to be an important fate process because glyphosate exists as a zwitterion at environmental pH (5-9) and ionic species do not volatilize. Volatilization from dry soil surfaces is not expected to be an important environmental fate process based on the vapour pressure. The biodegradation half-lives of glyphosate in a sandy loam and silt loam soil were 1.85 and 2.06 days, respectively under laboratory controlled (25°C) aerobic conditions. In eight field studies, in which glyphosate was applied at maximum usage rates to bare ground plots, the median dissipation half-time (DT_{50}) was 13.9 days.
If released to water, glyphosate is expected to adsorb to suspended solids and sediment in the water column based upon the Koc values. Volatilization from water surfaces is not expected to be an important fate process because ionic compounds do not volatilize. The aerobic and anaerobic biodegradation half-lives of glyphosate in a flooded silty clay loam sediment was 7 and 8.1 days, respectively. Glyphosate was stable to hydrolysis at pH 5, 7, and 9 at 5 to 35 °C. According to a classification scheme, BCF values of 0.2 to 0.63 measured in fish, suggest bioconcentration in aquatic organisms is low.

Occupational exposure may occur through inhalation of aerosols or dermal contact with this compound at workplaces where it is produced or used as a herbicide. The greatest potential for dermal and inhalation exposure to glyphosate is expected for pesticide applicators, farm workers, and members of the general population that have frequent contact with products containing glyphosate for commercial farming or home use.

3.11.3. Toxicology and ecotoxicology

- Acute toxicity: unlikely to be hazardous (WHO)
- Carcinogenicity: not listed
- Endocrine disruption: not listed
- Reproductive and developmental toxicity: not listed.

Terrestrial organisms

	Glyphosate	Glyphosate-trimesium
Acute toxicity to mammals:	2.1.6 LD_{50} > 2000 mg/kg bw	lowest LD_{50} 748 mg/kg bw
Acute toxicity to birds:	LD_{50} > 2000 mg/kg bw	lowest LD_{50} 950 mg/kg bw
Dietary toxicity to birds:	LC_{50} > 4640 ppm	LC_{50} > 5000 ppm
Reproductive toxicity to birds:	NOEC 200 ppm	NOEC 712 ppm
Short term oral toxicity to mammals:	NOAEL/NOEL 150 mg/kg bw/d (90 d, rat)	NOAEL/NOEL 25 mg/kg bw/d (90 d, rat)

Honeybees

	Glyphosate	Glyphosate-trimesium
Acute oral toxicity:	LD50: 100 µg as/bee	LD50: > 400 µg as/bee
Acute contact toxicity:	LD50: > 100 µg as/bee	LD50: > 400 µg as/bee

Earthworms

	Glyphosate	Glyphosate trimesium
Acute toxicity:	LC_{50} > 480 mg as/kg	LC_{50} > 1000 mg as/kg
Reproductive toxicity:	NOEC 28.79 mg/kg (IPA-salt)	NOEC 28.79 mg/kg (IPA-salt)

Soil micro-organisms

	Glyphosate	Glyphosate-trimesium
Nitrogen mineralization:	No effects up to 18 kg as/ha	No effects up to 18 kg as/ha
Carbon mineralization:	No effects up to 18 kg as/ha	No effects up to 18 kg as/ha

Aquatic organisms

	Glyphosate-IPA	Glyphosate-trimesium	Glyphosate acid (1st metabolite)
Acute toxicity fish: EC_{50}	>1000 mg /L	1800 mg/L	38 mg/L
Long term toxicity fish: NOEC	917 mg /L	50 mg/L	25 mg/L
Bioaccumulation fish:	Not relevant	Not relevant	Not relevant
Acute toxicity invertebrate: EC_{50}	930 mg /L	12 mg/L	40 mg/L
Chronic toxicity invertebrate: NOEC	455 mg /L	1.1 mg/L	30 mg/L
Chronic toxicity algae EC_{50}	72.9 mg/L	0.72 mg/L	0.64 mg/L (168 h)
Chronic toxicity sediment dwelling organism:	Not tested	Not tested	Not tested
Long-term toxicity aquatic plants: EC_{50}	53.6 mg/L	1.0 mg/L	12 mg/L

Test species Test method	**Glyphosate** % Effect	**Glyphosate-trimesium** % Effect
Typhlodromus pyri Lab on inert substrate	Lifecycle: 100 % mortality (3.6 kg as/ha)	Lifecycle: 100 % mortality (5.760 kg as/ha) LR_{50}: 0.211 kg as/ha
Typhlodromus pyri Lab natural substrate on leaves	Lifecycle: 89 % mortality (7.720 kg as/ha)	LR_{50}: 5.089 kg as/ha
Typhlodromus pyri Lab natural substrate on plants	Lifecycle: 30 % mortality; 0 % effect on fertility (3.708 kg as/ha)	---
Aphidius rhopalosiphi Lab on inert substrate	Adult: 100 % mortality	Adults: 100 % mortality (5.76 kg as/ha) LR_{50}: 0.043 kg as/ha
Aphidius rhopalosiphi Lab natural substrate on plants	Adult: 25 % mortality; 6 % effect on fertility (3.720 kg as/ha)	---
Aphidius rhopalosiphi Lab natural substrate on leaves	---	LR_{50}:> 8.4 kg as/ha
Orius insidiosus Lab on inert substrate	---	Lifecycle: 95 % mortality (5.760 kg as/ha)
Chrysoperla carnea Lab on inert substrate	Larval stage: 53 % mortality (0.712 kg as/ha)	---
Chrysoperla carnea Lab on inert substrate	Larval stage: 59 % mortality; 20 % effect on fertility (3.708 kg as/ha)	---
Drino inconspicua Lab on inert substrate	---	Adults: 56 % mortality; 76 % effect on parasitization (2.4 kg as/ha)
Pterostichus melaniarius Lab on inert substrate	---	Adults: 26.7% mortality (3.6 kg as/ha) Adults: 10% mortality (7.2 kg as/ha)
Aleochara bilineata Lab on inert substrate	Lifecycle: 1% parasitation capacity (1.63 kg as/ha)	---
Bembidion lampros Semifield	Adult: 0% mortality (4,890 kg as/ha)	---
Poecilus cupreus Lab on inert substrate	Adult: 0% mortality; 31% effect on food uptake (3.6 kg as/ha)	---

11 May 2001

Test species Test method	**Glyphosate** % Effect	**Glyphosate-trimesium** % Effect
Trechus quadristriatus Lab on inert substrate	Adult: 14% mortality (3.6 kg as/ha)	---
Pardosa spp. Lab on inert substrate	Adult: 56% mortality (3.7 kg as/ha)	Adults: 4 % mortality (3.6 kg as/ha) Adults: 0% mortality (7.2 kg as/ha)

HC5 = 4436 (2616 – 7520) µg/L derived from LC_{50} of aquatic animals exposed up to 4 days

3.11.4. Environmental standards/regulations

Water standards and criteria

U.S. National Drinking Water Standards and Health Criteria		Concentrations (µg/L - unless noted)
	Maximum contaminant level (MCL)	700
	Maximum contaminant level Goal (MCLG)	700
	One day exposure health advisory level	20000
	Ten days exposure health advisory level	20000
	Reference dose	2000 (µg/kg/day)
	U.S. Drinking Water Equivalent Level	70000
WHO Water Quality Criteria		30
Canada - Standards and Criteria		
Drinking water	Maximum acceptable concentration (MAC)	280
Canada - Water Quality Guidelines for the Protection of Aquatic Life	Freshwater	800
Canada - Water Quality Guidelines for the Protection of Agricultural Water uses	Livestock	280

Australian Drinking Water Guideline		100
	ANZECC trigger value (99% protection level)	370
French Water Quality Guideline		
	France – Threshold value freshwater PNEC	28
	France – Maximum acceptable concentration	64
	France – Environmental quality guideline	0.1

Regulations

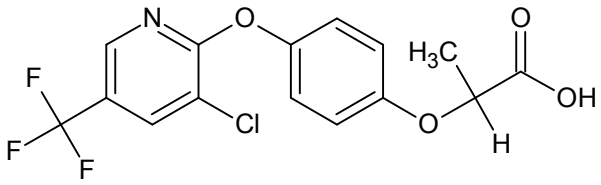
Registered for use in: 28 countries (including AU, CA, EU, India, NZ, US).

3.11.5. Important user information

On the basis of the proposed and supported uses, the following particular issues have been identified as requiring particular and short term attention from users, as appropriate:

- Groundwater: users must pay particular attention to the protection of the groundwater in vulnerable areas, in particular with respect to non-crop uses.

3.12. Haloxyfop



(Other forms: Haloxyfop-etotyl, Haloxyfop-methyl, Haloxyfop-P, Haloxyfop-P-methyl)

3.12.1. Physico-chemical properties

Cas number	69806-34-4
Name (IUPAC)	(RS)-2-{4-[3-chloro-5-(trifluoromethyl)-2-pyridyloxy]phenoxy}propionic acid
Use class	herbicide
Chemical class	Aryloxyphenoxy propionic acid
Appearance	crystalline
Melting point	107 - 108°C
Density	1.64
Vapour pressure	1.33×10^{-6} Pa
Solubility in water	43.4 mg/L at 25°C
Solubility (g/L) in organic solvents (at 20°C)	acetone: 1000 ethyl acetate: 518 xylene
Dissociation constant (pKa)	2.9
Adsorption coefficient (Koc)	75
Hydrolytic stability (DT_{50})	stable
Photostability in water (DT_{50})	12 d
Aerobic soil half-life	9 – 55d

3.12.2. Toxicology and ecotoxicology

- Acute toxicity: moderately hazardous (WHO)
- Carcinogenicity: not listed
- Endocrine disruption: not listed

Terrestrial organisms

Mammals - Acute oral LD_{50} (mg/kg)	337	Rat	Moderate
Birds - Acute LD_{50} (mg/kg)	2150	*Anas platyrhynchos*	Low

Aquatic organisms

Fish - Acute 96 hour LC_{50} (mg/L)	800	*Oncorhynchus mykiss*	Low
Aquatic invertebrates - Acute 48 hour EC_{50} (mg/L)	96.4	*Daphnia magna*	Moderate
Algae - Acute 72 hour EC_{50}, growth (mg/L)	106.5	Unknown species	Low

3.12.3. Environmental standards/regulations

Water standards and criteria

Australian Drinking Water Guideline: 1 µg/L

Regulations

Registered for use in: Two countries: Hungary, NZ (not approved in EU or US).

3.12.4. Important user information

N/A

3.13. Lime sulphur

3.13.1. Physico-chemical properties

Cas number	1344-81-6
Name (IUPAC)	Calcium polysulfide
Use class	Fungicide, Disinfectant, Insecticide
Chemical class	Inorganic compound
Appearance	Deep orange liquid
Boiling point	104.8°C
Relative density	1.28
Solubility in water	soluble
Aerobic soil half-life	730 d

3.13.2. Toxicology and ecotoxicology

Terrestrial organisms

Mammals - Acute oral LD_{50} (mg/kg)	1343	Rat	Moderate
Earthworms - Acute 14 day LC_{50} (mg/kg)	> 1000	*Eisenia fetida*	Moderate

Aquatic organisms

Fish - Acute 96 hour LC_{50} (mg/L)	> 2.86	*Oncorhynchus mykiss*	Moderate
Aquatic invertebrates - Acute 48 hour EC_{50} (mg/L)	> 6.6	*Daphnia pulex*	Moderate
Algae - Acute 72 hour EC_{50}, growth (mg/L)	> 12.6	*Pseudokirchneriella subcapitata*	Low

HC5 = 3041 (647 – 14290) µg/L derived from LC_{50} of aquatic animals exposed up to four days.

3.13.3. Environmental standards/regulations

Regulations

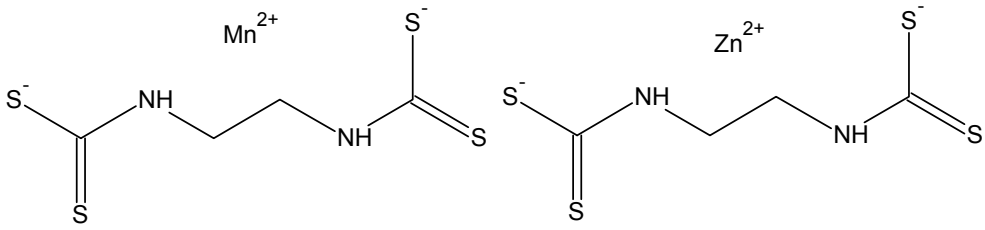
Registered for use in: 10 countries (including, AU, CA, NZ, SA, US).

3.13.4. Important user information

Users should pay attention to:

- operator safety and ensure that conditions of use prescribe the application of adequate personal and respiratory protective equipment in the phase of mixing-loading;
- the protection of aquatic organisms and non-target arthropods and shall ensure that the conditions of use include risk mitigation measures as appropriate.

3.14. Mancozeb



(Other form: ethylene thiourea)

3.14.1. Physico-chemical properties

Cas number	8018-01-7
Name (IUPAC)	manganese ethylenebis (dithiocarbamate) (polymeric) complex with zinc salt
Use class	Fungicide
Chemical class	Dithiocarbamate, inorganic zinc
Appearance	Yellowish powder (80%)
Vapour pressure	1.33×10^{5} Pa
Henry's law constant	KD < 5.9×10^{-4} Pa × m^3/mole (not volatile).
Relative density	1.9938 g/ml at 20°C, 1.976 g/ml at 22°C
Solubility in water	2 – 20 mg/L
Solubility (g/L) in organic solvents (at 25°C)	practically insoluble in organic solvent
Dissociation constants (pKa)	10.3
Partition coefficient (log Kow)	Indicative = 1.33 ETU Indicative: -0.85
Adsorption coefficient (Koc)	998
Hydrolytic stability (DT_{50})	< 1 d
Photostability in water (DT_{50})	pH 8.8 complete decomposition in 3hrs
Aerobic soil half-life	2

3.14.2. Environmental fate

The production of mancozeb may result in its release to the environment through various waste streams and its use as a fungicide will result in its direct release to the environment.

If released to air, a vapour pressure of 1.33×10^{5} Pa at 25°C indicates mancozeb will exist solely in the particulate phase in the atmosphere. Particulate-phase mancozeb

will be removed from the atmosphere by wet or dry deposition. Mancozeb has a photolysis rate constant of >5.5/day in air which equates to a half-life of <3 hrs.

If released to soil, mancozeb is expected to have moderate to slight mobility based upon Koc values of 363 to >2,000. Volatilization from moist soil surfaces is not expected to be an important fate process based upon an estimated Henry's Law constant of 5.9×10^{-4} Pa × m^3/mole. The biodegradation half-life of mancozeb in soil under aerobic conditions is < 2 days.

If released into water, mancozeb is expected to adsorb to suspended solids and sediment based upon the Koc values. Volatilization from water surfaces is not expected to be an important fate process based upon this compound's estimated Henry's Law constant. An estimated BCF of 4 suggests the potential for bioconcentration in aquatic organisms is low. Hydrolysis half-lives for mancozeb have been reported as 1.5, 2.3, and 0.7 days at pH 5, 7, and 9, respectively.

Occupational exposure to mancozeb may occur through inhalation of powder formulations and dermal contact with this compound at workplaces where mancozeb is produced or used. The general population may be exposed to mancozeb *via* ingestion of food treated with mancozeb and contact with fungicide products containing mancozeb.

3.14.3. Toxicology and ecotoxicology

Terrestrial organisms

Acute toxicity to mammals:	LD_{50}>5000 mg /kg bw ETU: Rat LD_{50} oral > 5000 mg/kg bw
Acute toxicity to birds:	LD_{50}>2000 mg./kg bw
Dietary toxicity to birds:	LC_{50}>5200 ppm (860 mg/kg bw/d)
Reproductive toxicity to birds:	NOEL: 125 ppm (18.8 mg/kg bw/d) Based on marked effects on reproductive performance at 1000 ppm.
Reproductive toxicity to mammals:	NOEL: 55 mg/kg bw/d (rabbit developmental NOEL) based on decreased maternal body weight, increased abortions, decreased number of litters at 80 mg a.s./kg bw/day. No foetal developmental effects. ETU: NOEL 150 ppm (two generation study in rat).

Honeybees

Acute oral toxicity:	LD50 140.6 µg as/bee
Acute contact toxicity:	LD50 161.7 µg as/bee

Other arthropod species

Effects on other arthropod species

Species	Stage	Test Substance	Dose (kg as/ha)	Endpoint	Effect %	Annex VI Trigger
Chrysoperla carnea[*]	larvae	Dithane M45	1.8	Mortality	9.4	30%
Episyrphus balteatus[*]	larvae	Dithane M45	1.8	Mortality	12.5	30%
Trichogramma cacoeciae[*]	adult	Dithane M45	1.8	Parasitic capacity	**>50**	30%
Cydnodromus californicus°	adult	Dithane M45	2	Mortality	0	30%
Amblyseius andersoni[*]	adult	Mancozeb tech	200 g/hl	Long term effect	**37.89**	30%
Amblyseius andersoni (S and R)°°	adult	Polyram c80	40	Short term effects (mortality and fecundity) Long term effect (mortality and fecundity)	25.36 (for R) **73.45** (for S) 31.82 (for R) 67.87 (for S)	30%

Typhlodromus pyri	Adult	Mancozeb tech	3.6	Long term effect	>75%	30%
Aphidius rhopalosiphi°	adult	Manex II	2.6	Mortality Reduced beneficial capacity	-0.4 36	30
Poecilus cupreus°	adult	Manex II	2.4	Mortality	0	30
Chrysoperla carnea°	larvae	Manex II	2.4	Mortality Reproduction rate	-0.3 12.2	30
Coccinella septempunctata°	larvae	Penncozeb 80	2-3	Mortality Reproduction rate	33.8 2.01	30
Aphidius rhopalosiphi°	adult	Sancozeb 800 wp	3.5	Mortality Reduced beneficial capacity	**64.9** **52.8**	30
Field study						
Cydnodromus californicus°° *P.ulmi*	adult	Dithane M 45	1.28 (0.16 kg a.i./hl)	Population reduction	40 (after 17 days) -100 (after 38 days)	none
Typhlodromus pyri°°	adult	Dithane Ultra WG	2x2.0, 2x3.0 4x2.0, 2x3.0	Population reduction	16.7 36.7	none

*Semi field test
°Laboratory test
°°Field test

Earthworms

Acute toxicity:	LC_{50} > 299.1 mg as/kg soil ETU: LC_{50} > 1000* mg/kg soil. 14 d
Reproductive toxicity:	NOEC: 161 mg as/kg (mortality) NOEC: 20 mg as/kg (reproduction)

Soil micro-organisms

Nitrogen mineralization:	no effects on soil microflora at 4 kg as/ha (6.68 mg as/kg dry soil) ETU: no effects on soil microflora at concentrations = 0.56 – 5.6 mg/kg (equivalent to 0.42-4.2 kg as/ha)
Carbon mineralization:	no effects on soil microflora at 4 mg as/ha (6.68 mg as/kg dry soil) ETU: no effects on soil at concentrations = 0.56 – 5.6 mg/kg (equivalent to 0.42-4.2 kg as/ha)

Aquatic organisms

Toxicity data for aquatic species

	Group	Test substance	Time-scale	End-point	Toxicity (mg/l)
Acute toxicity fish:	Laboratory tests				
	Rainbow trout	Mancozeb tech	96h	LC_{50}	**0.074*** 0.088**
	Rainbow trout	Mancozeb 80% WP	96h	LC_{50}	0.11 mg product/l (0.088 mg as/L)**
	Rainbow trout	Penncpzeb 80 WP	96h	LC_{50}	0.18 mg product/l (0.15 mg as/L)
	Rainbow trout	ETU	96h	LC_{50}	>490
Long term toxicity fish:	Rainbow trout	Sancozeb 800 WP	Prolonged tox. test 14 days	NOEC	0.66 mg as/L**
	Fathead minnow	Dithane M - 45	early life stage 34 d	NOEC	0.00219*
Bioaccumulation fish:	Not requested: logPow = 1.38				

Acute toxicity invertebrate:	*Daphnia magna*	Mancozeb tech	48h	EC_{50}	**0.073***
	Daphnia magna	Mancozeb 80% wdp	24h	EC_{50}	0.014 mg product /l (0.011 mg as/l)**
	Daphnia magna	Penncpzeb 80 WP	48h	EC_{50}	0.47 mg product/l (0.39 mg as/l)**
	Daphnia magna	ETU	48h	EC_{50}	21.6
Chronic toxicity invertebrate:	*Daphnia magna*	Mancozeb tech	21days chronic	NOEC	**0.0073***
	Daphnia magna	Sancozeb 800 WP	21days chronic	NOEC	0.029 mg as/l**
	Daphnia magna	ETU	21days chronic	NOEC	2
Acute toxicity algae:	*Chlorella P.*	ETU	96h	ErC_{50}	6600
	Selenastrum capricor-nutum	Dithane M - 45	120h	EC_{50}	**0.044*****
	Pseudo-kirchneriella s.	ETU	72h static	ErC_{50}	93.8
	Xenopus leavis	ETU	Metamorphosis assay 28 d Semi static	NOEC	10
Chronic toxicity sediment dwelling organism:	Not requested				
Higher tier studies	Rainbow trout	Dithane M - 45	Fish Species Sensitivity Distribution Study+ 96 h	**LC_{50}**	**0.073** mg as/l 0.050 mg as/l)
	Invertebrates and phytoplankton	Penncozeb 80 WP	Invertebrate Phytoplankton Mesocosm	**EAC**	**0.032 mg as/l**
	Brachionus calyciforus	Penncozeb 80 WP	Acute 24 h	EC_{50}	0.11 mg as/L
	Lymnae stagnalis	Penncozeb 80 WP	Acute 48 h	EC_{50}	>113 mg as/L
	Gammarus sp.	Penncozeb 80 WP	Acute 48 h	EC_{50}	3.0 mg as/L
	Asellus sp.	Penncozeb 80 WP	Acute 48 h	EC_{50}	4.4 mg as/L

*Mean measured concentration at the end of the test.
**Nominal, analytically confirmed concentration > 80% recovery.
***Initial measured concentration.
Values **in Bold** were used for risk assessment

Fish Species Sensitivity Distribution Study 10 species of freshwater fish were tested for 96 hours acute toxicity in shallow (30 cm), static sediment/water microcosms. Test material (Dithane M-45) was applied once in 5 test concentrations under the water surface. Analytical confirmation indicated that all initial concentrations were >80% of nominal, therefore, results were expressed as nominal initial concentrations. The most sensitive fish species was rainbow trout 96 hours LC_{50} = 0.073 mg as/L (NOEC=0.050 mg as/L). Results in the other species of fish were (96 hr LC50's mg as/L): fathead minnow 0.57; channel catfish 0.68; bluegill sunfish 0.84; three-spined stickleback 0.93; zebra fish 0.95; largemouth bass 1.0; guppy 1.3; golden medaka 1.4; common carp 1.7. **Invertebrate/Phytoplankton Microcosm study** No NOECcommunity could be derived because there were still long term effects at the lowest tested concentration (reduction of the abundance of clams). The study was conducted at pH 5.5-7: mancozeb hydrolysed very fast in acid environment and much slower under alkaline conditions. For this reason the study can be use in a risk evaluation of mancozeb in more or less acid surface waters.
Invertebrate/Phytoplankton Mesocosm study The study is adequate for risk evaluation for phyto- and zoo-planckon communities and aquatic diptera. The Ecological Acceptable Concentration is 32 µg as/l applicable to aquatic risk assessment scenarios involving 8 or fewer applications.

HC5 = 152 (85 – 272) µg/L derived from LC50 of aquatic animals exposed up to 16 days.

3.14.4. Environmental standards/regulations

Water standards and criteria

Australian Drinking Water Guideline: 9 µg/L (based on ethyl thiourea).

Regulations

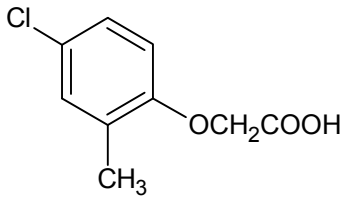
Registered for use in: 22 countries (including, AU, EU, CA, NZ, SA, US)
Listed for concern: not in the Groundwater Protection List (or approved by Department of Pesticide Regulation).

3.14.5. Important user information

Users should pay particular attention to:

- the potential for groundwater contamination, when the active substance is applied in regions with vulnerable soils and/or extreme climatic conditions.
- the residues in food and evaluate the dietary exposure of consumers.
- the protection of birds, mammals, aquatic organisms and non-target arthropods and must ensure that the conditions of authorisation include, where appropriate, risk mitigation measures.

3.15. MCPA



(Other forms: MCPA-thioethyl, MCPA 2-ethyl hexyl ester, MCPA alkanolamine salt, MCPA butoxyethanol ester, MCPA butyl ester, MCPA diethanolamine salt, MCPA diisopropanolamine salt, MCPA dimethylamine salt, MCPA ester, MCPA ethanolamine salt, MCPA isobutyl ester, MCPA isooctyl ester, MCPA isopropanolamine salt, MCPA isopropyl ester, MCPA mixed amine salt, MCPA potassium salt, MCPA sodium salt, MCPA triethanolamine salt, MCPA triisopropanolamine salt)

3.15.1. Physico-chemical properties

Cas number	94-74-6
Name (IUPAC)	4-chloro-o-tolyoxyacetic acid
Use class	herbicide
Chemical class	Chlorophenoxy acid or ester
Appearance	White solid
Melting point	115.4°C to 116.8°C. Purity = 99.5%.
Boiling point	Decomposition observed at approx.. 290°C
Relative density	1.41 Purity 99.9%
Vapour pressure	4.43×10^{-8} Pa at 25°C 4×10^{-4} Pa at 32°C 4×10^{-3} Pa at 45°C. Purity 99.4%
Henry's law constant	5.5×10^{-5} Pa.m^3/mol at 25°C
Solubility in water	Unbuffered (pH1) 0.395g/L at 25°C. pH5: 26 g/L at 25°C pH7: 293 g/L at 25° pH9:320 g/L at 25°C Purity 99.4%

Solubility (g/L) in organic solvents (at 25°C)	Toluene 26.5 Dichloromethane 69.2 Methanol 775.6 Propanol-2 425.6 Acetone 487.8 Ethylacetate 289.3 n-Hexane 0.323 n- Octanol 218.3
Dissociation constants (pKa)	3.73
Partition coefficient (log Kow)	pH1: 2.70 (0.001 Mol/l); 2.80 (0.0001 Mol/l) pH5: 0.28 (0.01 Mol/l); 0.59 (0.001 Mol/l) pH7: -0.81 (0.01 Mol/l); -0.71 (0.001 Mol/l) pH9: -1.07 (0.01 Mol/l); -0.88 (0.001 Mol/l) Purity 99.4%.
Adsorption coefficient (Koc)	74
Hydrolytic stability (DT_{50})	stable
Photostability in water (DT_{50})	25.4 d in natural sunlight pH 5
Aerobic soil half-life	24 d

3.15.2. Environmental fate

The use of 2-Methyl-4-chlorophenoxyacetic acid (MCPA) as a commercial herbicide is expected to result in its direct release to the environment.

If released to air, a vapour pressure of 4.43×10^{-8} Pa at 25°C indicates MCPA will exist in both the vapour and particulate phases in the ambient atmosphere. Vapour-phase MCPA will be degraded in the atmosphere by reaction with photochemically-produced hydroxyl radicals; the half-life for this reaction in air is estimated to be 31 hours. Particulate-phase MCPA will be removed from the atmosphere by wet and dry deposition. Field studies have shown that aerial drift from spray applications can transport MCPA to nearby ponds and streams. MCPA may undergo direct photolysis in the air since it is photochemically reactive in water.

If released to soil, MCPA is expected to have high mobility based upon a Koc ranging from 50 to 62. Various monitoring studies have shown that field applications of MCPA are subject to runoff (*via* rainfall) with subsequent transport (relatively small amounts) to streams and ponds. Volatilization from moist soil surfaces is not expected to be an important fate process based upon a Henry's Law constant of 5.5×10^{-5} $Pa.m^3/mol$ at 25°C. The half-life of MCPA in soil ranges from <7 to 41 days with an average of approximately 2-3 weeks, with more rapid degradation occurring in acclimated soils. Biodegradation appears to be slower in drier soils and in flooded (anaerobic) soils.

If released into water, MCPA is not expected to adsorb to suspended solids and sediment based upon its Koc. Biodegradation of MCPA is expected to occur in water based upon its biodegradability in soil, with more rapid degradation following acclimation. Volatilization from water surfaces is not expected to be an important fate process based upon this compound's Henry's Law constant. A BCF of 1 suggests that the potential for bioconcentration in aquatic organisms is low. Hydrolysis of MCPA is not expected to occur because of the lack of hydrolyzable functional groups. Occupational exposure to MCPA may occur through inhalation, swallowing of spray droplets, and dermal contact with this compound at workplaces where MCPA is produced or used. Monitoring and biodegradation data suggest that the general population is not expected to be exposed to MCPA

3.15.3. Toxicology and ecotoxicology

- Acute toxicity: Slightly hazardous (WHO), highly toxic (EPA)
- Carcinogenicity: possible (IARC)
- Endocrine disruption: not listed

Terrestrial organisms

	MCPA	**MCPA-thioethyl**
Acute toxicity to mammals:	LD_{50} rat 962 $mg.kg^{-1}$ bw.	14 d LD_{50} rat 450 $mg.kg^{-1}$ bw.
Acute toxicity to birds:	LD_{50} bobwhite quail 270 $mg.kg^{-1}$	LD_{50} bobwhite quail >400 $mg.kg^{-1}$. Phenothiol (20%)
Dietary toxicity to birds:	LC_{50} > 5620 mg $as.kg^{-1}$ diet (>983 $mg.kg^{-1}$ d^{-1}) NOEC 562 mg $as.kg^{-1}$ diet (Mallard duck)	LC_{50} bobwhite quail > 1040 mg $as.kg^{-1}$ diet. Phenothiol (20%)
Reproductive toxicity to birds:	NOEC bobwhite quail 1000 ppm Equivalent to a mean intake of 93.2 mg as.kg $bw^{-1}.d^{-1}$	To be dealt with at MS level.
Short term toxicity to mammals:	NOAEL (from 90 d rat study at 450 ppm): 37.8 $mg.kg^{-1}$	To be dealt with at MS level.

Honeybees

	MCPA	MCPA-thioethyl
Acute oral toxicity:	LD_{50} > 200 µg/bee	LD_{50} > 100 µg formulation/bee. Phenothiol (20% EC)
Acute contact toxicity:	LD_{50} > 200 µg/bee	LD_{50} > 100 µg formulation/bee. Phenothiol (20% EC)

Other arthropod species

Test species		MCPA	
	Application (kg as/ha)	Stage	Effects / Endpoints
Pardosa sp	2	Adult/subadult	0% mortality (harmless)

Earthworms

	MCPA	MCPA-thioethyl
Acute toxicity	14 d LC_{50} 325 mg as/kg dry soil	14 d LC_{50} 140.5 mg as/kg dry soil
Reproductive toxicity	Not required	Not required

Soil micro-organisms

	MCPA	MCPA-thioethyl
Nitrogen mineralization	No effect (28 d) at 2.67 mg as/kg dry wt. soil corresponding to the highest recommended rate of application (2 kg/ha) and at 26.7 mg as/kg dry wt soil corresponding to 10 times the highest recommended rate of application (20 kg/ha) (Ammonification and nitrification)	<25% of deviation at 1.224 kg as/ha (28 d)
Carbon mineralization	No effect (28 d) at 2.67 mg as/kg dry wt. soil corresponding to the highest recommended rate of application (2 kg/ha) and at 26.7 mg as/kg dry wt soil corresponding to 10 times the highest recommended rate of application (20 kg/ha) (Ammonification and nitrification)	<25% of deviation at 1.224 kg as/ha (28 d)

Aquatic organisms

Organism group	Acute toxicity range
Amphibians	Slight Toxicity
Crustaceans	Not Acutely Toxic
Fish	Not Acutely Toxic to High Toxicity
Insects	Not Acutely Toxic
Molluscs	Slight Toxicity
Zooplankton	Slight Toxicity

	MCPA				MCPA-thioethyl			
	Species	Time scale	Toxicity (mg/l)	End point	Species	Time scale	Toxicity (mg/l)	End point
Acute toxicity fish:	*Oncorhynchus mykiss*	96 h Flow through	50 mg as* /l	LC_{50}	*Oncorhynchus mykiss*	96 h	0.3 mg as/l	LC_{50}
					Salmo gairneri	96h	0.75 mg as/l	LC_{50}
Long term toxicity fish:	*Pimephales promelas*	28 d Flow through	15 mg as/l	NOEC	*Salmo gairneri*	28 d	0.2 mg as/l	NOEC
Bioaccumulation fish:	Not required log P < 3				Not provided			
Acute toxicity invertebrate:	*Daphnia magna*	48 h Flow trough	>190 mg a.i. /l	EC_{50}	*Daphnia magna*	48 h	0.58 mg as/l	EC_{50}
					Daphnia magna	48 h	0.072 mg as/l	EC_{50}
Chronic toxicity invertebrate:	*Daphnia magna*	21 d Flow trough	50 mg as* /l	NOEC	*Daphnia magna*	21 d	0.009 mg as/l	NOEC
Acute toxicity algae:	*Selenastrum capricornutum*	120 h	79.8 mg as /l (cell density) >392 mg as /l (growth rate)	EC_{50}	*Scenedesmus subspicatus*	72 h	>2.3 mg as/l	ErC_{50} Growth inhibition
	Navicula pelliculosa	120 h	32.9 mg a.i. /l (cell density) 117 mg a.i. /l (growth rate)	EC_{50}	*Selenastrum capricornutum*	72 h	0.92 mg as/l	EbC_{50}
Chronic toxicity sediment dwelling organism:	Not Required				Not required			
Acute toxicity aquatic plants: (for herbicides only)	*Lemna gibba G3*	14 d	152 µg as./l	IC_{50}	To be dealt with at MS level.			

* as for these aquatic end points is MCPA DMA

Aphidius rhopalosiphi	2Tier 1 test	Adult	100% Mortality	Provided. To be dealt with at MS level.		
Aphidius rhopalosiphi	2.1; 0.025 Tier 2 test on barley seedlings	Adult	0 % Mean corrected Mortality - - 0.8 Reproduction factor	Provided. To be dealt with at MS level.		
Typhlodromus pyri	0.2, 2 L/ha	Protonymphs/ adult	0 % Mean corrected Mortality (harmless)	Provided. To be dealt with at MS level.		
Chrysoperla carnea	4 L/ha	Larvae/adult	0 % Mean corrected Mortality - Reproduction unaffected (R = 1.00)	Provided. To be dealt with at MS level.		

HC5 = 284 (6 – 14502) µg/L derived from LC_{50} of aquatic animals exposed up to four days.

3.15.4. Environmental standards/regulations

Water standards and criteria

U.S. National Drinking Water Standards and Health Criteria		Concentrations (µg/L)
	Maximum contaminant level (MCL)	0
	One day exposure health advisory level	100
	Ten days exposure health advisory level	100
	Lifetime Exposure Health Advisory Level	30
	Reference dose	4 (µg/kg/day)
	U.S. Drinking Water Equivalent Level	140
WHO Water Quality Criteria		20 µg/L
Canada Standards and Criteria		Concentrations (µg/L)
Canada Water Quality Guidelines for the Protection of Aquatic Life	Freshwater	2.6 (interim)

Canada Water Quality Guidelines for the Protection of Agricultural Water uses	Irrigation	0.025
	Livestock	25
Australian Drinking Water Guideline		40 µg/L
	ANZECC trigger value	1.4 µg/L

Regulations

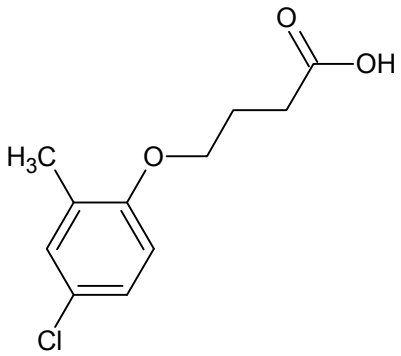
Registered for use in: 17 countries (AU, EU, CA, NZ, US)
Banned in: Thailand
Reasons for the final regulatory action were relevant to: Human health.

3.15.5. Important user information

Users should pay particular attention to:

- the potential for groundwater contamination, when the active substance is applied in regions with vulnerable soil and/or climatic conditions. Conditions of authorisation should include risk mitigation measures, where appropriate.
- the protection of aquatic organisms and must ensure that the conditions of authorisation include risk mitigation measures, where appropriate, such as buffer zones.

3.16. MCPB



(Other form: MCPB sodium salt)

3.16.1. Physico-chemical properties

Cas number	94-81-5
Name (IUPAC)	4-(4-chloro-o-tolyloxy)butyric acid
Use class	Herbicide
Chemical class	Chlorophenoxy acid or ester
Appearance	Technical (962 g/kg) and purified material (986 g/kg) White solid (flake or powder) N8/ (Munsell). Phenolic like odour
Relative density	Technical material (965 g/kg) = 1.254 at 22°C. Purified material (986 g/kg) = 1.233 at 20°C.
Vapour pressure	Purified material (998 g/kg) = 4×10^{-6} Pa at 25°C 5.3×10^{-5} Pa at 20 °C
Henry's law constant	4.3×10^{-5} Pa.m^3/mol
Solubility in water	Purified material (>900 g/Kg): 25.0 ± 2.2 mg/L at 20°C Purified material (986 g/kg) pH 5 buffered 20ºC = 0.11 g/L pH 7 buffered 20ºC = 4.4 g/L pH 9 buffered 20ºC = 444 g/L
Solubility (g/L) in organic solvents (at 20°C) (Technical material 962 g/kg)	Methanol: 386 Ethylacetate:228 n-heptane: 3 Xylene: 74.1 1,2 dichloroethane: 69.3 n-Octanol: 157 Acetone: 452

Partition coefficient (log Kow)	Purified material (986 g/kg) pH 5 log Kow= > 2.37 (20ºC). pH 7 log Kow= 1.32 (20ºC). pH 9 log Kow= - 0.17 (20ºC).
Adsorption coefficient (Koc)	pH <7: 86-130
Hydrolytic stability (DT_{50})	Stable at pH 5, 7 and 9 for 30 days at 25ºC % degradation of the parent compound were: 4.6% at pH 5; 4.1% at pH 7; 2.8% at pH 9.
Dissociation constants (pKa)	4.5 at 21°C (purity 96.68%)
Aerobic soil half-life	11 to 30 d
Photostability in water (DT_{50})	The calculated photodegradation half-lives were pH 5 = 2.2 d pH 7 = 2.6 d pH 9 = 2.4 d The 5 major photolysis products at pH 5, 7 and 9 are: 1) 4-(4-hydroxy-o-tolyloxy)butyric acid; 2) 2,4-dihydroxyphenyl formate; 3) o-cresol; 4) benzoic acid; 5) 2-hydroxyphenyl formate

3.16.2. Environmental fate

The production of 2-Methyl-4-chlorophenoxybutyric acid may result in its release to the environment through various waste streams and its use as a herbicide will result in its direct release to the environment.

If released to air, a vapour pressure of 5.3×10^{-5} Pa at 20 °C indicates that 2-methyl-4-chlorophenoxybutyric acid is expected to exist in both the vapour and particulate-phases in the ambient atmosphere. Vapour-phase 2-methyl-4-chlorophenoxybutyric acid is degraded in the atmosphere by reaction with photochemically-produced hydroxyl radicals; the half-life for this reaction in air is estimated to be 19 hours. Particulate-phase 2-methyl-4-chlorophenoxybutyric acid will be removed from the atmosphere by wet or dry deposition. 2-methyl-4-chlorophenoxybutyric acid underwent photolysis in aqueous solutions exposed to sunlight, suggesting that photolysis in air may be possible.

If released to soil, 2-methyl-4-chlorophenoxybutyric acid is expected to have low mobility based upon an estimated Koc value of 780. Volatilization from moist soil surfaces will not be an important fate process since 2-methyl-4-chlorophenoxybutyric acid is a weak acid with pKa 4.84 and exists primarily as an anion. 2-methyl-4-chlorophenoxybutyric acid is not expected to volatilize from dry soil surfaces based

upon its vapour pressure. Biodegradation half-lives of less than 7 days in 3 soils, indicates that 2-methyl-4-chlorophenoxybutyric acid is not persistent in the environment.

If released into water, 2-methyl-4-chlorophenoxybutyric acid is expected to adsorb to suspended solids and sediment based upon the estimated Koc. Volatilization from water surfaces will not be an important environmental fate process since 2-methyl-4-chlorophenoxybutyric acid exists primarily as an anion in water and anions do not volatilize. 2-Methyl-4-chlorophenoxybutyric acid is stable to hydrolysis at pH 5-9, but photolyzed in aqueous solutions under optimal light exposure conditions with half-lives of approximately 2 to 3 days. An estimated BCF value of 3, suggests the potential for bioconcentration in aquatic organisms is low.
Occupational exposure to 2-methyl-4-chlorophenoxybutyric acid may occur through inhalation of dust and dermal contact with this compound at workplaces where 2-methyl-4-chlorophenoxybutyric acid is produced or used.

3.16.3. Toxicology and ecotoxicology

Terrestrial vertebrates

Acute toxicity to mammals:	Acute oral LD_{50} (rat) 4700 mg as./kg b.w.
Acute toxicity to birds:	Acute oral LD_{50} 282 mg/kg bw, Bobwhite quail.
Dietary toxicity to birds:	8-d LD_{50} > 5000 ppm MCPB NOEL 1250 ppm (bodyweight gain and food consumption).
Reproductive toxicity to birds:	Not performed for MCPB. For MCPA, NOEL 1000ppm (highest dose tested) bobwhite quail.
Short term oral toxicity to mammals:	NOEL= 13 mg/kg/d (6-week oral rat).

Honeybees

Acute oral toxicity:	48-h LD_{50} (MCPB acid) - > 81.83 µg as/bee
Acute contact toxicity:	48-h LD_{50} (MCPB acid) - > 100 µg as/bee

Other arthropod species

Test species			
	Rate (kg.as/ha)	Stage	Effects/Endpoint
Aphidius rhopalosiphi	0.25, 0.5, 1.0, 2.0, 4.0	Adult	50% mortality at 2 kg/ha, 47% at 4 kg/ha Reproduction factor = 0.68 at 4kg/ha, 0.84 at 2kg/ha. LR_{50} > 4kg/ha
Typhlodromus pyri	2	Protonymph /adult	Mean Corrected Mortality 34.44% (d 7) Reproductive index 1.049.LR_{50} >2kg/ha
Aleochara bilineata	2.25	Adult/ hatchlings	No behavioural effects. Reproductive index = 1.06
Poecilus cupreus	2.25	Adult	Mortality 0%, no effect on food consumption

Earthworms

Acute toxicity:	D 7, LC_{50} = 382 ppm; D 14, LC_{50} = 263 ppm.
Reproductive toxicity:	Not performed.

Soil micro-organisms

Nitrogen mineralization:	MCPB – effect at 10kg/ha, recovered by d 42.
Carbon mineralization:	MCPB < 25% effect (28 d) at 10 Kg as/ha.

Aquatic organisms

	Species	Test Substance	Time scale	Toxicity expressed as acid (mg/l)	Endpoint
Acute toxicity fish:	*Lepomis macrochirus*	Technical material (MCPB sodium)	96 h	14	Mortality EC_{50}
	Oncorhynchus mykiss	Technical material (MCPB sodium)	96 h	4.3	Mortality EC_{50}
	Oncorhynchus mykiss	MCPA DMA Formulation	96 h	41	Mortality EC_{50}
Long term toxicity fish:	*Oncorhynchus mykiss*	MCPA DMA Formulation	28 d	40	NOEC
Bioaccumulation fish:	Not required, K_{OW} = 2.79				
Acute toxicity invertebrate:	*Daphnia magna*	Technical material (MCPB sodium)	48 h	55	EC_{50}
Chronic toxicity invertebrate:	*Daphnia magna*	Technical material (MCPA DMA salt)	21 d	50	Reproduction, NOEC

	Selenastrum capricornutum	Technical material (MCPB sodium)	72 h	41	Biomass, E_bC_{50}
	Selenastrum capricornutum	*(MCPA DMA Formulation)*	72 h	*57*	*Biomass, E_bC_{50}*
	Anabaena flos-aquae	Technical material (MCPB sodium)	120 h	>2	EC_{50}
	Navicula pelliculosa	Technical material (MCPB sodium	72 h	1.5	Biomass, E_bC_{50}
Chronic toxicity sediment dwelling organism:	Not Required,				
Acute toxicity aquatic plants: (for herbicides only)	*Lemna gibba*	Technical material	17 d	37	Fronds, E_bC_{50}

HC5 = 1324 (184 – 9518) µg/L derived from LC_{50} of freshwater fish exposed up to four days.

3.16.4. Environmental standards/regulations

Regulations

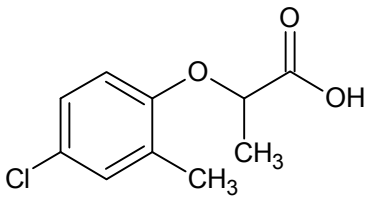
Registered for use in: Six countries (including AU, CA, EU, NZ, US)
Banned in: Thailand
Reasons for the final regulatory action were relevant to: Human health.

3.16.5. Important user information

Users should pay particular attention to:

- the potential for groundwater contamination, when the active substance is applied in regions with vulnerable soil and/or climatic conditions. Conditions of authorisation should include risk mitigation measures, where appropriate.
- the protection of aquatic organisms and must ensure that the conditions of authorisation include, where appropriate, risk mitigation measures.

3.17. Mecoprop (MCPP)



3.17.1. Physico-chemical properties

Cas number	93-65-2 / 7085-19-0
Name (IUPAC)	(*RS*)-2-(4-chloro-o-tolyloxy)propionic acid
Use class	herbicide
Chemical class	Chlorophenoxy acid or ester
Appearance	White to light brown crystalline solid
Relative density	1.37
Vapour pressure	1.6×10^{-3} Pa
Henry's law constant	$2.20 \text{ X } 10^{-04}$ $Pa.m^3/mole$
Solubility in water	734 mg/L
Solubility (g/L) in organic solvents (at 20°C)	n-heptane: 4.11 xylene: 126 ethyl acetate: 469
Dissociation constants (pKa)	3.11
Partition coefficient (log Kow)	-0.19
Adsorption coefficient (Koc)	47
Hydrolytic stability (DT_{50})	31d, stable pH 5 to pH 9
Photostability in water (DT_{50})	pH 5: 42 d, pH 7: 44 d, pH 9: 32 d
Aerobic soil half-life	13 d
Anaerobic soil half-life	541 d

3.17.2. Environmental fate

The production of mecoprop may result in its release to the environment through various waste streams and its use as a herbicide will result in its direct release to the environment.

If released to air, a vapour pressure of 1.6×10^{-3} Pa at 25°C indicates mecoprop will exist in both the vapour and particulate phases in the atmosphere. Vapour-phase mecoprop will be degraded in the atmosphere by reaction with photochemically-produced hydroxyl radicals; the half-life for this reaction in air is estimated to be 22 hours. Particulate-phase mecoprop will be removed from the atmosphere by wet or dry deposition. Mecoprop contains chromophores that absorb at wavelengths between 280 and 290 nm and, therefore, may be susceptible to direct photolysis by sunlight.

If released to soil, mecoprop is expected to have very high mobility based upon Koc values of 5 to 47. The pKa of mecoprop is 3.11, indicating that this compound will exist almost entirely in anion form in the environment and anions generally do not adsorb more strongly to soils containing organic carbon and clay than their neutral counterparts. Volatilization from moist soil is not expected because the acid exists as an anion and anions do not volatilize. Biodegradation half-lives have been experimentally determined to be 3 to 70 days depending on soil type, water content, temperature and depth in soil. If released into water, mecoprop is not expected to adsorb to suspended solids and sediment based upon the Koc values.

Mecoprop, present at 100 ppb, degraded in 30 days in groundwater at 10°C after a 35-40 day lag; degradation took less than a week when re-spiked. Volatilization from water surfaces is not expected to be an important fate process based upon this compound's pKa. An estimated BCF of 3 suggests the potential for bioconcentration in aquatic organisms is low. Hydrolysis is not expected to be an important environmental fate process since this compound lacks functional groups that hydrolyze under environmental conditions. Mecoprop, exposed to sunlight, had a photodegradation half-life of 19.5 and 14.0 days in river and seawater, respectively.

Occupational exposure to mecoprop may occur through inhalation and dermal contact with this compound at workplaces where mecoprop is produced or used. Monitoring data indicate that the general population may be exposed to mecoprop *via* inhalation of ambient air, ingestion of contaminated drinking water, and dermal contact with this compound in treated areas.

3.17.3. Toxicology and ecotoxicology

Please note that the studies are performed with different active ingredients or formulations, therefore the following abbreviations are used:

MCPP: Mecoprop, the “true” active ingredient, the raceme, acid form.
MCPP-P: Mecoprop-P, the active isomer, acid form.
MCPP DMA: The dimethyleamine salt of mecoprop.

Terrestrial vertebrates

Acute toxicity to mammals:	Rat acute oral LD_{50} = 1166 mg/kg bw MCPP
Acute toxicity to birds:	LD50 > 500 mg/kg bw MCPP
Dietary toxicity to birds:	LC50 = 5000 ppm MCPP, 5 + 3 days
Reproductive toxicity to birds:	NOEC = 673 ppm MCPP-P DMA equivalent to 556 ppm MCPP-P
Short term oral toxicity to mammals:	Rat 3 month dietary: NOAEL = 150 ppm MCPP (11.4 mg/kg bw/day)

Honeybees

Acute oral toxicity:	LD_{50} > 100 µg MCPP-P DMA/bee (> 83 µg MCPP-P/bee) LD_{50} > 100 µg Duplosan KV/bee (> 60 µg MCPP-

	P/bee)
Acute contact toxicity:	LD_{50} > 100 µg MCPP-P DMA/bee (> 83 µg MCPP-P/bee)

Other arthropod species

Test species	Dose (kg as/ha)	Effect
Carabid beetle	3.360 g/ha as MCPP	28 % reduction
Carabid beetle	1.064 g/ha as MCPP-P	No reduction, 23 % mortality
Rove beetle	1.064 g/ha as MCCP-P	No significant effect
Rove beetle	3.360 g/ha as MCPP	No significant effect
Parasitoid wasp	1.8 kg/ha as MCPP-P	Overall combination of mortality and fecundity E=7.7%
Predatory mite	1.8 kg/ha as MCPP-P	23.5 %, not significant

Earthworms

Acute toxicity:	Studied using the product U 46 KV-Fluid containing MCPP DMA: LC_{50} = 988 mg MCPP/kg soil
Reproductive toxicity:	No data available, not required.

Soil micro-organisms

Nitrogen mineralization:	U 46 KV-Fluid containing MCPP DMA: Ammonification and nitrification comparable to control after 28 days at 3.36 and 33.6 kg MCPP/ha.
Carbon mineralization:	U 46 KV-Fluid (MCPP DMA): Respiration deviated less than 10% from control after 28 days at 3.36 and 33.6 kg MCPP/ha. Duplosan KV (MCPP-P DMA): Dehydrogenase activity normalised after 56 days except in a sandy soil at 5 times normal application rate.

Aquatic organisms

	Time-scale	End point	Toxicity (mg/l)
Acute toxicity fish:	96 hours	LC_{50}	240
Long term toxicity fish:	21days	Toxicity NOEC	109
Bioaccumulation fish:	**BCF** Whole fish: 3.0, non-edible: 5.5, edible: 1.2. Clearance time (CT_{50}): Whole fish: 27 hours, non-edible: 38 hours, edible: 7.8 hours		
Acute toxicity invertebrate:	48 hours	EC_{50}	> 200
Chronic toxicity invertebrate:	21 days	Repro. NOEC	22
Acute toxicity algae:	72 hour	biomass E_bC_{50}	237
Chronic toxicity sediment dwelling organism:	No data available, not required		
Acute toxicity aquatic plants:	7 days	E_rC_{50}	40.2
All tests conducted with MCPP DMA, results expressed in MCPP equivalents.			

HC5 = 3353 (44 – 255368) µg/L derived from LC50 of fish exposed up to four days. The reliability of the HC5 is low due to the low number of studies.

3.17.4. Environmental standards/regulations

Regulations

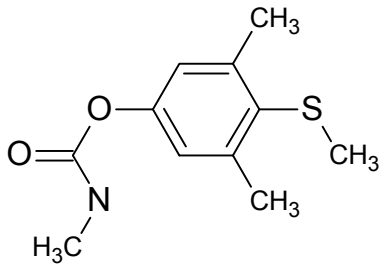
Registered for use in: AU, EU, NZ, US
Banned in: Thailand
Reasons for the final regulatory action were relevant to: Human health.

3.17.5. Important user information

Users should pay particular attention to:

- the potential for groundwater contamination, when the active substance is applied in regions with vulnerable soil and/or climatic conditions. Conditions of authorisation should include risk mitigation measures, where appropriate.
- the protection of non-target arthropods. Risk mitigation measures should be applied, where appropriate.

3.18. Methiocarb



3.18.1. Physico-chemical properties

Cas number	2032-65-7
Name (IUPAC)	4-methylthio-3,5-xylyl methylcarbamate
Use class	insecticide, molluscicide
Chemical class	N-methyl carbamate
Appearance	White crystalline powder
Melting point	119°C
Boiling point	311°C
Relative density	1.25
Vapour pressure	1.50 X 10^{-02} at 25°C
Henry's law constant	1.20 X 10^{-04} Pa m^3/mole at 20°C
Solubility in water (mg/L)	27
Solubility (g/L) in organic solvents (at 20°C)	acetone: 144 dichloromethane: 200 isopropanol: 53 toluene: 33 hexane: 1.3
Partition coefficient (log Kow)	2.92
Adsorption coefficient (Koc)	660
Hydrolysis half-life	24 d at 20°C
Photolytic stability (DT_{50})	11 d
Aerobic soil half-life	64 d
Anaerobic soil half-life	64 d

3.18.2. Environmental fate

The production of methiocarb may result in its release to the environment through various waste streams and its use as a molluscicide and acaricide will result in its direct release to the environment.

If released to air, a vapour pressure of 1.50×10^{-02} at 25°C indicates methiocarb will exist in both the vapour and particulate phases in the ambient atmosphere. Vapour-phase methiocarb will be degraded in the atmosphere by reaction with photochemically-produced hydroxyl radicals; the half-life for this reaction in air is estimated to be 29 hours. Methiocarb also absorbs light in the environmental UV spectrum and has a photolysis half-life in the range of six to 16 days. Particulate-phase methiocarb will be removed from the atmosphere by wet and dry deposition.

If released to soil, methiocarb is expected to have low mobility based upon an estimated Koc of 660. Volatilization from moist soil surfaces is not expected to be an important fate process based upon a Henry's Law constant of $1.20 \text{ X } 10^{-04}$ Pa m^3/mole at 20°C. Methiocarb is not expected to volatilize from dry soils based upon its vapour pressure. The biodegradation half-life of methiocarb in soil was reported to range from 17 to 111 days under aerobic conditions and about 64 days under anaerobic conditions. The photolysis half-life of methiocarb in 3 different soils was shown to range from 4 to 9 days.

If released into water, methiocarb is expected to adsorb to suspended solids and sediment based upon the estimated Koc. Volatilization from water surfaces is not expected to be an important fate process based upon this compound's Henry's Law constant. Hydrolysis is expected to be an important fate process for methiocarb in moist soil and water, with half-lives of 35 days and 6 hours at pH 7 and 9, respectively. Photolysis in sunlit surface water is expected to be an important fate process based on a photolysis half-life of 23 minutes when aqueous solutions of methiocarb were irradiated with UV light of wavelength 286-400 nm. An estimated BCF of 35 – 75 suggests the potential for bioconcentration in aquatic organisms is moderate.

Occupational exposure to methiocarb may occur through inhalation and dermal contact with this compound at workplaces where methiocarb is produced or used. Monitoring data indicate that the general population may be exposed to methiocarb *via* ingestion of food.

3.18.3. Toxicology and ecotoxicology

Terrestrial organisms

Mammals - Acute oral LD_{50} (mg/kg)		19	Rat	High
Mammals - Short term dietary NOEL	(mg/kg)	1.3	Rat	High
	(ppm diet)	10		-
Birds - Acute LD_{50} (mg/kg)		5	*Coturnix japonica*	High
Birds - Short term dietary (LC_{50}/LD_{50})		1071	*Anas platyrhynchos*	

(mg kg feed^{-1})			
Honeybees - Acute 48 hour LD_{50} (µg bee^{-1})	0.23	Contact	High
Earthworms - Acute 14 day LC_{50} (mg/kg)	1322		Low
Earthworms - Chronic 14 day NOEC, reproduction (mg/kg)	0.32		Moderate
Other arthropod (1) LR_{50} g ha^{-1}	0.47	48 hours *Aphidius rhopalosiphi*, adult	Harmful at 1 kg/ha
Other arthropod (2) LR_{50} g ha^{-1}	33.7	7 day *Typhlodromus pyri*	Harmful at 1 kg/ha
Soil micro-organisms	Nitrogen mineralisation: No significant effect Carbon mineralisation: No significant effect	Dose: 1.7 mg/kg soil	-

Aquatic organisms

Fish - Acute 96 hour LC_{50} (mg/L)	0.65	*Oncorhynchus mykiss*	Moderate
Fish - Chronic 21 day NOEC (mg/L)	0.05	*Oncorhynchus mykiss*	-
Aquatic invertebrates - Acute 48 hour EC_{50} (mg/L)	0.008	*Daphnia magna*	High
Aquatic invertebrates - Chronic 21 day NOEC (mg/L)	0.0001	*Daphnia magna*	
Algae - Acute 72 hour EC_{50}, growth (mg/L)	2.2	*Scenedemus subspicatus*	Moderate
Algae - Chronic 96 hour NOEC, growth (mg/L)	3.2	Unknown species	Low

HC5 = 15.6 (6.4 – 37.9) µg/L derived from LC_{50} of aquatic animals exposed up to four days.

3.18.4. Environmental standards/regulations

Water standards and criteria

Australian Drinking Water Guideline: 7 µg/L

Regulations

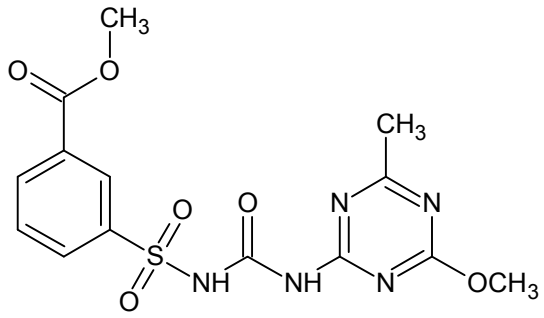
Registered for use in: 13 countries (including, AU, EU, NZ, SA, US)
Listed for concern: Groundwater Protection List of Department of Pesticide Regulation (DPR, CA, 2013).

3.18.5. Important user information

Users must pay particular attention to:

- the protection of birds, mammals and other non-target arthropods. Conditions of authorisation should include risk mitigation measures;
- the operator and bystander safety and ensure that conditions of use prescribe the application of adequate personal and respiratory protective equipment.
- the dietary exposure of consumers in view of future revisions of Maximum Residue Levels

3.19. Metsulfuron



3.19.1. Physico-chemical properties

Cas number	74223-64-6
Name (IUPAC)	Methyl 2-(4-methoxy-6-methyl-1,3,5,-triazin-2-ylcarbamoylsulfamoyl) benzoate
Use class	Herbicide
Chemical class	Sulfonylurea
Appearance	off white solid
Melting point	162°C (97.4% purity)
Relative density	1.447 (97.4% purity)
Vapour pressure	1.1×10^{-10} Pa (20°C), 3.3×10^{-10} Pa (25°C)
Henry's law constant	2.3×10^{-10} Pa.m^3/mole (pH 5) 4.5×10^{-11} Pa.m^3/mole (pH 7) (99.4% purity)
Solubility in water	pH 5: 548 mg/L (25°C) pH 7: 2.79 g/L (25°C) pH 9: 213 g/L (25°C)
Solubility (g/L) in organic solvents (at 25°C, 97.4% purity)	n-hexane: 0.000584 acetone: 37 methanol: 7.63 dichloromethane: 132 acetonitrile: 25.9
Dissociation constants (pKa)	3.75
Partition coefficient (log Kow)	-1.7 (pH 7, 25°C)
Adsorption coefficient (Koc)	57
Hydrolytic stability (DT_{50})	pH 5: DT_{50} 22 d at 25 °C (radiolabelled purity 99.4%) pH 7: DT_{50} > 30 d at 25 °C pH 9: DT_{50} >30 d at 25 °C No degradation
Photostability in water (DT_{50})	pH 5, pH 7 and pH 9 no degradation
Aerobic soil half-life	24 d
Anaerobic soil half-life	65 d

3.19.2. Environmental fate

The production of metsulfuron methyl may result in its release to the environment through various waste streams and its use as a herbicide will result in its direct release to the environment.

If released to air, a vapour pressure of 3.3×10^{-10} Pa (25°C) indicates metsulfuron methyl will exist solely in the particulate phase in the atmosphere. Particulate-phase metsulfuron methyl will be removed from the atmosphere by wet or dry deposition. Metsulfuron methyl may undergo direct photolysis based on 50 and 76% degradation of this substance in an aqueous solution after 15 and 36 hours exposure to UV irradiation (greater than or equal to 290 nm), respectively.

If released to soil, metsulfuron methyl is expected to have moderate to very high mobility based upon Koc values ranging from 4-345. Volatilization from moist soil surfaces is not expected to be an important fate process based upon an estimated Henry's Law constant of 2.3×10^{-10} Pa.m3/mole (pH 5). The pKa of metsulfuron methyl is 3.75, indicating that urea nitrogens in this compound will exist primarily in anion form in the environment and anions generally do not adsorb more strongly to organic carbon and clay than their neutral counterparts. Metsulfuron methyl is not expected to volatilize from dry soil surfaces based upon its vapour pressure. Metsulfuron methyl is expected to biodegrade in soil based on half-lives of 27, 60, and 17-69 days for this substance in non-sterile soil compared with half-lives of 54, 108, and 99-139 days in sterile soil. Reported half-life values for soil include: clay – 178 days; sandy loam – 102 days; clay loam 14-105 days; silty loam - 120-180 days.

If released into water, metsulfuron methyl is expected to have little to no adsorption to suspended solids and sediment based upon the range of Koc values. Metsulfuron methyl is expected to biodegrade in water based on its behavior in soil. Volatilization from water surfaces is not expected to be an important fate process based upon this compound's estimated Henry's Law constant. BCF values ranging from 1-17 suggest bioconcentration in aquatic organisms is low. Metsulfuron methyl is expected to undergo hydrolysis in the environment based on measured half-lives of 4-9.6, 116, 99-139, and 87 days at pH 5.2, 7.1, 8.2, and 10.2, respectively and temperatures of 25-28°C.

Occupational exposure to metsulfuron methyl may occur through dermal contact with this compound at workplaces where metsulfuron methyl is produced or used.

3.19.3. Toxicology and ecotoxicology

Terrestrial organisms

Acute toxicity to mammals	LD50 (rats) > 5 000 mg/kg NOAEL (90 d, rats) = 100 ppm
Long term oral toxicity to mammals:	NOAEL (90 d, rat) = 100 ppm
Acute toxicity to birds:	LD50 (mallard duck) > 2 510 mg/kg
Dietary toxicity to birds:	LC50 (bobwhite quail) > 5 620 ppm LC50 (mallard duck) > 5 620 ppm
Reproductive toxicity to birds:	NOEC = 1 000 ppm

Honeybees

Acute oral toxicity:	LD50 > 44.3 microg a.s./bee
Acute contact toxicity:	LD50 > 25 microg a.s./bee

Other arthropod species

Chrysoperla camea	E (beneficial effect) = - 3.5 % (WG 20%)
Typhlodromus pyri	E (beneficial effect) = - 1.2 % (WG 20%)
Poecilus cupreus	E (mortality) = 3.5 % (WG 20%) E (prey consumption) = 3%
Aleochara bilineata	E (beneficial effect) < 30 % (WG 20%)
Aphidius rhopalosiphi	E (beneficial effect) = 19.3 % (WG 20%)

Earthworms

Acute toxicity:	LC50 > 1 000 mg a.s./kg dry soil *Metabolites* LC50 > 1 000 mg IN-A4098/kg dry soil LC50 > 1 mg IN-00581/kg dry soil LC50 > 1 mg IN-B5067/kg dry soil LC50 > 1 mg IN-NC148/kg dry soil
Reproductive toxicity:	No data submitted

Soil micro-organisms

Nitrogen mineralization:	0.2 mg a.s./kg: No effect
Carbon mineralization:	0.2 mg a.s./kg: No effect

Aquatic organisms

Active substance:

Acute toxicity fish:	LC50 (96 h) > 150 mg/l
Chronic toxicity fish:	NOEC (21 d) = 68 mg/l
Bioaccumulation fish:	log P_{ow} = - 1,7 (pH 7.0) whole fish: < 1
Acute toxicity invertebrate:	EC50 (48 h, *D. magna*) > 150 mg/l
Chronic toxicity invertebrate:	NOEC (21 d, daphnids) = 150 mg/l
Acute toxicity algae:	EC_b50 (72 h, *S. capricornutum*) = 0.045 mg/l
Acute toxicity (aquatic plants):	EC50 (*L. gibba*) = 0.00036 mg/l
Chronic toxicity sediment dwelling organism:	not required

Preparation (WG 20%):

Acute toxicity fish:	LC50 (trout, 96 h) > 1 000 mg/l
Acute toxicity invertebrate:	EC50 (daphnids) > 1 000 mg/l

Metabolites:

Acute toxicity fish:	LC50 (trout) = 981 mg IN-JX909/l
Acute toxicity invertebrate:	EC50 (daphnids) = 971 mg IN-JX909/l
Acute toxicity algae:	EC50 (*S. capricornutum*) = 64 mg IN-JX909/l
Acute toxicity (aquatic plants)	EC50 *(L. gibba*) = 30 mg IN-JX909/l EC50 *(L. gibba*) > 10 mg IN-A4098/l

Indicative HC5 calculated at 75.3 mg/L (no 95% CI) derived from LC50 of fish exposed four days. The reliability of this value is very low due to the low number of studies.

3.19.4. Environmental standards/regulations

Water standards and criteria

Australian Drinking Water Guideline: 40 µg/L

Regulations

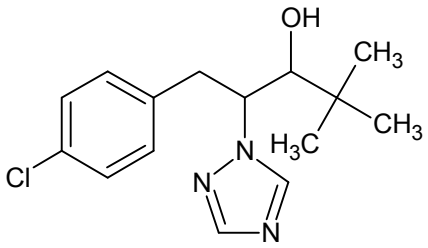
Registered for use in: 16 countries (including, AU, CA, NZ, SA, US)
Listed for concern: EU-WFD Annexe 1

3.19.5. Important user information

Users must carefully consider the risk to aquatic plants and algae if this active substance is applied directly adjacent to surface waters. The exposure input from drain flow with respect to local conditions should also be considered. Where appropriate, risk mitigation measures (*e.g.* buffer zones) should be applied.

Particular attention should be given to the potential for groundwater contamination, when the active substance is applied in regions with vulnerable soil (*e.g.* soils with high pH values) and/or extreme climatic conditions.

3.20. Paclobutrazol



3.20.1. Physico-chemical properties

Cas number	76738-62-0
Name (IUPAC)	(2RS,3RS)-1-(4-chlorophenyl)-4,4-dimethyl-2-(1H-1,2,4-triazol-1-yl)pentan-3-ol
Use class	Plant growth regulator
Chemical class	Azole
Appearance	White crystalline solid
Melting point	166°C
Relative density	1.23
Vapour pressure	1.9×10^{-3} Pa at 25°C
Henry's law constant	8.39×10^{-6} Pa.m^3/mole
Solubility in water	26 mg/L
Solubility (g/L) in organic solvents (at 20°C)	acetone: 72.4 xylene: 5.67 methanol: 150 n-heptane: 0.199
Partition coefficient (log Kow)	3.2
Adsorption coefficient (Koc)	400
Hydrolytic stability (DT_{50})	stable pH4 to pH9 over 30 d at 25°C
Aerobic soil half-life	29.5 d – 120 d

3.20.2. Environmental fate

The half-life of paclobutrazol in soil varied from less than 84 to greater than 140 days under aerobic conditions, depending upon the amount of organic material in the soil. Photolysis did not affect the half-life of paclobutrazol in buffered solutions. The compound did not hydrolyze under acid, base, or neutral conditions. Paclobutrazol had a high octanol:water partition coefficient, had a low mobility in soil, and was degraded relatively slowly in soil.

Workers involved in paclobutrazol application have potential exposure *via* dermal contact, and inhalation. Estimates of potential exposure were based on surrogate data from fluvalinate applications. Fluvalinate has been applied in greenhouses at rates and label conditions similar to those proposed for paclobutrazol. Estimates of potential acute absorbed dosages from maximum use of paclobutrazol were 67.9 ug/kg for mixer/loader/applicators, and 9.1 ug/kg for greenhouse workers. Estimates of potential chronic absorbed dosages from maximum use were 6.5 ug/kgday for mixer/loader/applicators, and 6.0 ug/kg-day for greenhouse workers. Based on the currently available toxicity information, paclobutrazol causes adverse effects on liver function and developmental effects in rodents. In the absence of additional data to the contrary, paclobutrazol has the potential to cause similar effects in humans (Cochran *et al.* 2002).

3.20.3. Toxicology and ecotoxicology

- Acute toxicity: slightly hazardous (WHO)
- Carcinogenicity: unclassifiable, inadequate data (EPA)
- Endocrine disruption: not listed

Terrestrial organisms

Mammals - Acute oral LD_{50} (mg/kg)		1336	Rat	Moderate
Mammals - Short term dietary NOEL	(mg/kg)	2.5	Rat	High
	(ppm diet)	50		-
Birds - Acute LD_{50} (mg/kg)		> 2100	*Colinus virginianus*	Low
Birds - Short term dietary (LC_{50}/LD_{50}) mg kg feed^{-1}		> 2000	*Colinus virginianus*	
Honeybees - Acute 48 hour LD50 (µg bee^{-1})		> 2	Oral	Moderate
Earthworms - Acute 14 day LC50 (mg/kg)		> 500	*Eisenia fetida*, corr	Moderate
Earthworms - Chronic 14 day NOEC, reproduction (mg/kg)		0.68	*Eisenia fetida*, corr	Moderate
Other arthropod (1) LR_{50} (g/ha)		16.7	48 hour *Aphidius rhopalosiphi*	Harmful at 1 kg/ha
Other arthropod (2) LR_{50} (g/ha)		1000	7 day *Typhlodromus pyri*	Harmful at 1 kg/ha

Soil micro-organisms	Nitrogen mineralisation: No significant effect @ 77 days Carbon mineralisation: No significant effect @ 21 days	Dose: 20 kg/ha	

Aquatic organisms

Organism group	Acute toxicity range
Amphibians	Slight Toxicity
Annelida	Slight Toxicity
Fish	Slight Toxicity
Molluscs	Slight Toxicity
Zooplankton	Slight Toxicity

Fish - Acute 96 hour LC_{50} (mg/L)	23.6	*Lepomis macrochirus*	Moderate
Fish - Acute 96 hour LC_{50} (mg/L)	27.8	*Oncorhynchus mykiss* (Rainbow trout)	Moderate
Fish - Chronic 21 day NOEC (mg/L)	3.3	*Salmo gairdneri*	-
Aquatic invertebrates - Acute 48 hour EC_{50} (mg/L)	33.2	*Daphnia magna*	Moderate
Aquatic invertebrates - Chronic 21 day NOEC (mg/L)	0.32	*Daphnia magna*	
Aquatic plants - Acute 7 day EC50, biomass (mg/L)	0.0082	*Lemna gibba*	High
Algae - Acute 72 hour EC_{50}, growth (mg/L)	7.2	*Pseudokirchneriella subcapitata*	Moderate

HC5 = 10511 (8080 – 13673) µg/L derived from LC50 of aquatic animals exposed up to four days.

3.20.4. Environmental standards/regulations

Water standards and criteria

Australian Drinking Water Guideline: 100 µg/L

Regulations

Registered for use in: 14 countries (including AU, CA, NZ, SA, US)

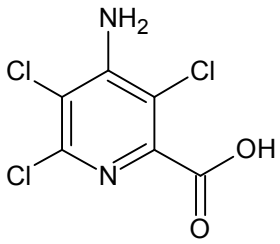
3.20.5. Important user information

Users shall pay particular attention to the risk to aquatic plants. Conditions of use shall include risk mitigation measures, where appropriate.

Potential acute and chronic dosages with corresponding margins of safety (Cochran *et al.* 2002).

Workers	Potential exposure dosage (µg/kg/day)	Margin of safety
Acute		
Mixer/ loader / applicator	67.9	147
Greenhouse worker	9.1	1099
Chronic		
Mixer/ loader / applicator	6.5	1538
Greenhouse worker	6	1667

3.21. Picloram



(Other forms: Picloram alkanolamine salt, Picloram diethanolamine salt, Picloram isooctyl ester, Picloram isopropanolamine salt, Picloram monoethanolamine salt, Picloram potassium salt, Picloram triethanolamine salt, Picloram triethylamine salt, Picloram triisopropanolamine salt)

3.21.1. Physico-chemical properties

Cas number	1918-02-1
Name (IUPAC)	4-amino-3,5,6-trichloropyridine-2-carboxylic acid
Use class	herbicide
Chemical class	Pyridinecarboxylic acid
Appearance	Crystalline white solid
Melting point	218.5°C
Relative density	1.71
Vapour pressure	8×10^{-14} Pa at 25°C
Henry's law constant	3×10^{-7} Pa m^3/mole at 25°C
Solubility in water	430 mg/L at 25°C
Solubility (g/L) in organic solvents (at 25°C)	acetone: 19.8 acetonitrile: 1.6 benzene: 0.2 diethyl ether: 1.2 isopropanol: 5.5
Dissociation constant (pKa)	2.3 at 22°C
Partition coefficient (log Kow)	-1.92
Adsorption coefficient (Koc)	13
Hydrolytic stability (DT_{50})	Stable
Photostability in water (DT_{50})	2 d in summer sunlight 40°N at pH 5
Aerobic soil half-life	18 – 300 d
Anaerobic soil half-life	300 d

3.21.2. Environmental fate

The production of picloram may result in its release to the environment through various waste streams and its use as a herbicide will result in its direct release to the environment.

If released to air, a vapour pressure of 8×10^{-14} Pa (6×10^{-16} mm Hg) at 25°C indicates Picloram will exist solely in the particulate phase in the atmosphere. Particulate-phase picloram will be removed from the atmosphere by wet or dry deposition. Picloram does not contain chromophores that absorb at wavelengths >290 nm and, therefore, is not expected to be susceptible to direct photolysis by sunlight.

If released to soil, picloram is expected to have very high to high mobility based upon Koc values of 0.026 to 100. The pKa of picloram is 2.3, indicating that this compound will exist almost entirely in anion form in the environment and anions generally do not adsorb more strongly to soils containing organic carbon and clay than their neutral counterparts. Leaching potential is greatest in sandy soils low in organic matter. Volatilization from moist soil is not expected because the acid exists as an anion and anions do not volatilize. Aerobic degradation half-lives for picloram at various application rates in soil ranged from 18 days at 0.0025 ppm to 300 days at 2.5 ppm. Based on these half-lives, picloram is expected to biodegrade in soil.

If released into water, picloram is not expected to adsorb to suspended solids and sediment based upon the Koc values. The amount of non-degraded picloram in groundwater from 4 sites after incubation for 15 weeks was 60.7 to 82.4%. Based on this data, picloram may biodegrade in aquatic environments. Volatilization from water surfaces is not expected to be an important fate process based upon this compound's pKa. BCFs of 0.11 to 31 in fish suggest bioconcentration in aquatic organisms is low. Picloram is stable to hydrolysis over the pH range of 5 to 9.

Occupational exposure to picloram may occur through inhalation and dermal contact with this compound at workplaces where picloram is produced or used. Monitoring data indicate that the general population may be exposed to picloram *via* inhalation of ambient air, ingestion of food and drinking water that contains picloram, or dermal contact with this compound

3.21.3. Toxicology and ecotoxicology

- Acute toxicity: unlikely to be hazardous (WHO), slightly toxic (EPA)
- Carcinogenicity: unlikely (EPA)
- Endocrine disruption: on EU list

Terrestrial organisms

Mammals - Acute oral LD_{50} (mg/kg)	4012	Rat	Low
Mammals - Short term dietary NOEL (ppm diet)	20	Rat, 2 year	-
Birds - Acute LD_{50} (mg/kg)	> 1944	*Anas platyrhynchos*	Moderate
Birds - Short term dietary (LC_{50}/LD_{50}) mg kg $feed^{-1}$	> 5620	*Colinus virginianus*	-
Honeybees - Acute 48 hour LD_{50} (µg bee^{-1})	> 74	Oral	Moderate
Earthworms - Acute 14 day LC_{50} (mg/kg)	> 4475	*Eisenia fetida*	Low
Earthworms - Chronic 14 day NOEC, reproduction (mg/kg)	0.167	*Eisenia fetida*, 8 week	Moderate
Other arthropod (1) LR_{50} (g/ha)	23.45	*Aphidius rhopalosiphi*	Harmful at 1 kg/ha
Other arthropod (2) LR_{50} (g/ha)	23.45	*Typhlodromus pyri*	Harmful at 1 kg/ha

Aquatic organisms

Organism group	Acute toxicity range
Amphibians	Not Acutely Toxic
Crustaceans	Not Acutely Toxic
Fish	Slight to Moderate Toxicity
Zooplankton	Slight Toxicity

Fish - Acute 96 hour LC_{50} (mg/L)	8.8	*Oncorhynchus mykiss*	Moderate
Fish - Chronic 21 day NOEC (mg/L)	0.55	*Oncorhynchus mykiss*	-
Aquatic invertebrates - Acute 48 hour EC_{50} (mg/L)	44.2	*Daphnia magna*	Moderate
Aquatic invertebrates - Chronic 21 day NOEC (mg/L)	6.79	*Daphnia magna*	
Sediment dwelling organisms - Chronic 28 day NOEC, static, water (mg/L)	100	*Chironomus riparius*	Low

Aquatic plants - Acute 7 day EC_{50}, biomass (mg/L)	102	*Lemna gibba*	Low
Algae - Acute 72 hour EC50, growth (mg/L)	60.2	*Pseudokirchneriella subcapitata*	Low

HC5 = 5135 (3107 – 8487) µg/L derived from LC_{50} of aquatic animals exposed up to 10 days.

3.21.4. Environmental standards/regulations

Water standards and criteria

U.S. National Drinking Water Standards and Health Criteria		Concentration (µg/L)
	Maximum contaminant level (MCL)	500
	Maximum contaminant level goal (MCLG)	500
	State Drinking Water Guideline (Arizona)	49
	One day exposure health advisory level	20000
	Ten days exposure health advisory level	20000
	Reference dose	20 (µg/kg/day)
	U.S. Drinking Water Equivalent Level	700
Canada Standards and Criteria		
	Drinking Water	µg/L
	Maximum Acceptable Concentration (MAC)	190
Canada Water Quality Guidelines for the Protection of Aquatic Life	Freshwater	29 (interim)
Canada Water Quality Guidelines for the Protection of Agricultural Water uses	Livestock	190

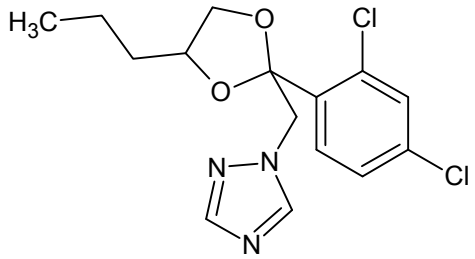
Regulations

Registered for use in: Eight countries (including, AU, CA, EU, NZ, US)
Listed for concern: not in the Groundwater Protection List (or approved by Department of Pesticide Regulation).

3.21.5. Important user information

Users should pay attention to the potential for groundwater contamination when picloram is applied in regions with vulnerable soil and/or climatic conditions. Conditions of authorisation must include risk mitigation measures, where appropriate.

3.22. Propiconazole



3.22.1. Physico-chemical properties

Cas number	60207-90-1
Name (IUPAC)	(±)-1-[2-(2,4-dichlorophenyl)-4-propyl-1,3-dioxolan-2-ylmethyl]-1H-1,2,4-triazole
Use class	Fungicide
Chemical class	Azole
Appearance	Clear, viscous liquid
Relative density	1.32 at 20°C (99.8% pure)
Vapour pressure	5.6×10^{-5} Pa at 25°C (99.1% pure)
Henry's law constant	9.2×10^{-5} Pa.m^3/mol
Solubility in water	150 mg/L at 20°C (pH 5.2)
Solubility (g/L) in organic solvents (at 20°C)	acetone, dichloromethane, methanol, ethyl acetate, and xylene: completely miscible n-heptane: 1.585
Dissociation constants (pKa)	1.09 at 20°C
Partition coefficient (log Kow)	3.75 at 25°C and pH 6.6
Adsoprtion coefficient (Koc)	656
Hydrolytic stability (DT_{50})	25-85 d
Photostability in water (DT_{50})	47-984 d at 30-50°N latitude
Aerobic soil half-life	72 d
Anaerobic soil half-life	211 d

3.22.2. Environmental fate

The production of propiconazole may result in its release to the environment through various waste streams and its use as a fungicide will result in its direct release to the environment.

If released to air, a vapour pressure of 5.6×10^{-5} Pa at 25°C indicates propiconazole will exist in both the vapour and particulate phases in the atmosphere. Vapour-phase propiconazole will be degraded in the atmosphere by reaction with photochemically-

produced hydroxyl radicals; the half-life for this reaction in air is estimated to be 5.5 hours. Particulate-phase propiconazole will be removed from the atmosphere by wet or dry deposition. Propiconazole has been reported to be stable to photolysis.
If released to soil, propiconazole has reported soil mobility ranging from moderate to immobile depending on the organic carbon content of the soil. Propiconazole is not expected to volatilize from dry soil surfaces based upon its vapour pressure.

Volatilization from water and moist soil surfaces is not expected to be an important fate process based upon an estimated Henry's Law constant 9.2×10^{-5} Pa.m^3/mole. An estimated BCF of 146 suggests the potential for bioconcentration in aquatic organisms is very high. Propiconazole has been reported to be stable in both aqueous and soil environments. Propiconazole has been reported to be stable to hydrolysis as well as aqueous and soil photolysis.

Occupational exposure to propiconazole may occur through dermal contact with this compound at workplaces where propiconazole is produced or used.

3.22.3. Toxicology and ecotoxicology

Terrestrial organisms

Acute toxicity to mammals:	Propiconazole: Acute toxicity LD_{50} > 1490 mg a.i./kg body weight Long-term toxicity NOEL 500 ppm
Acute toxicity to birds:	Propiconazole: LD_{50} > 2510 mg a.i./kg body weight (mallard duck, bobwhite quail)
Dietary toxicity to birds:	Propiconazole: LC_{50} > 5620 mg a.i./kg food (mallard duck, bobwhite quail)
Reproductive toxicity to birds:	Propiconazole: NOEC > 300 mg a.i./kg food (mallard duck)
Short term oral toxicity to mammals:	Lowest relevant oral NOAEL/NOEL 20 ppm (2.7 mg/kg bw/day; 17 week, mice)

Honeybees

Acute oral toxicity:	LD_{50} > 100 ug/ai/bee (propiconazole)
Acute contact toxicity:	LD_{50} > 100 µg/ai/bee (propiconazole)

Other arthropod species

Test species	% Effect
Coccinella septempunc.	4% mortality - 15 % reproductivity increased (125 g ai/ha, A 6097 G)
Syrphus corollae	45 % mortality 49 % fertility 72 % beneficial capacity (125 g ai/ha, A 6097 G)
Typhlodromus pyri	49.5, 85.9, 91.4 % mortality 81.9 % benefical capacity (18.8, 94, 250 g ai/ha, A 6097 K)
Poecilus cupreus	0 % (Mortality) (18.8, 94, 250 g ai/ha, A 6097 K)
Chrysoperla carnea	- 8.6 %, - 8.6% and 0 % (Mortality) 3.4 %, 19.6 % and 23.0 % (Reproduction) (18.8, 94, 250 g ai/ha, A 6097 K)

Aquatic organisms

	Group	Test substance	Time - scale	End point	Toxicity (mg/l)
Acute toxicity fish:	Leiostomus xanthurus	Propiconazole	96 h	LC_{50}	2.6
	Oncorhynchus mykiss	Metabolite, CGA 217 495	96 h	LC_{50}	> 100
	Lepomis macrochirus	Tilt 250 EC (A 6097 K)	96 h	LC_{50}	6.7
Long term toxicity fish:	Cyprinodon variegatus	Propiconazole	100 d	NOEC	0.068
Bioaccumulation fish:	116 (bluegill); 98 % of propiconazole has been eliminated during 14 day depuration period				
Acute toxicity invertebrate:	Daphnia magna	Propiconazole	48 h	EC_{50}	10.2
	Daphnia magna	Metabolite, CGA 217 495	48 h	EC_{50}	> 100
	Daphnia magna	Tilt 250 EC (A 6097 K)	48 h	EC_{50}	6.9
	Mysidopsis bahia	Propiconazole	96 h	LC_{50}	0.51
	Crassostrea virginica	Propiconazole	96 h	EC_{50}	1.7
Chronic toxicity invertebrate:	Daphnia magna	Propiconazole	21 d	NOEC	0.31
Chronic toxicity sediment dwelling organism:	Chironomus riparius	Propiconazole	28 d	Emergence, NOEC	8.0 (water) 25.0 (sed.)
				Development, NOEC	4.0 (water) 50.0 (sed.)

HC5 = 471 (210 – 1057) µg/L derived from LC_{50} of aquatic animals exposed up to four days.

3.22.4. Environmental standars/regulations

Regulations

Registered for use in: 19 countries (including, AU, CA, EU, NZ, SA, US).

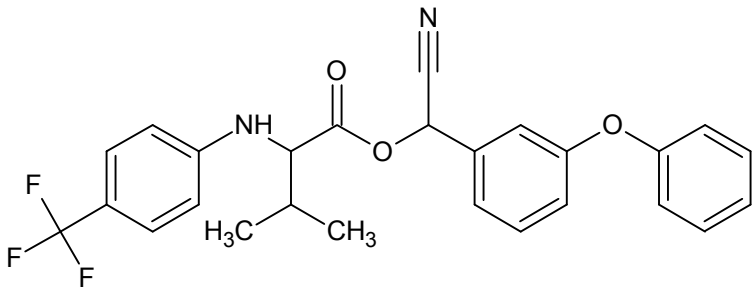
3.22.5. Important user information

Users should pay particular attention to:

- the protection of non-target arthropods and aquatic organisms. Conditions of authorisation should include risk mitigation measures, where appropriate.

- the protection of soil organisms for applications rates exceeding 625 g ai./ha (*e.g.* uses in turf). Conditions of authorisation should include risk mitigation measures (*e.g.* spot-wise application scheme), where appropriate.

3.23. Tau-fluvalinate



3.23.1. Physico-chemical properties

Cas number	102851-06-9
Name (IUPAC)	(RS)-α-cyano-3-phenoxybenzyl N-(2-chloro-α,α,α-trifluoro-p-tolyl)-D-valinate
Use class	Insecticide
Chemical class	Pyrethroid
Appearance	Yellow-amber liquid
Boiling point	164°C
Relative density	1.29
Vapour pressure	9.00 X 10^{-8} at 25°C
Henry's law constant	1.20 X 10^{-4} Pa m^3 /mole at 25°C
Solubility in water	0.00103 mg/L
Solubility (g/L) in organic solvents (at 20°C)	acetone: 500 hexane: 100 methanol: 500
Partition coefficient (log Kow)	7.02
Adsoprtion coefficient (Koc)	135000
Hydrolytic stability (DT_{50})	22.5 d
Photostability in water (DT_{50})	4 d
Aerobic soil half-life	3.5 – 135 d

3.23.2. Environmental fate

The production of fluvalinate may result in its release to the environment through various waste streams and its use as an insecticide will result in its direct release to the environment.

If released to air, a vapour pressure of 9 ×10^{-8} at 25°C indicates fluvalinate will exist in the particulate phase in the atmosphere. Particulate-phase fluvalinate will be removed from the atmosphere by wet or dry deposition.

If released to soil, fluvalinate is expected to have no mobility based upon Koc value of 135000. Volatilization from moist soil surfaces is not expected to be an important fate process based upon an estimated Henry's Law constant of 1.20 X 10^{-4} Pa m^3 /mole at 25°C. Fluvalinate will not volatilize from dry soil surfaces based upon its vapour pressure. A field study measured fluvalinate half-lives of 6.8-8.0 days in an agricultural soil. A laboratory study using a sandy loam, clay and clay loam soils observed half-lives of 6-8 days under aerobic conditions and about 15 days under anaerobic conditions. Laboratory tests have shown that fluvalinate photodegrades rapidly (half-life of 1 day) on glass, soil and plant surfaces exposed to sunlight.

If released into water, fluvalinate is expected to adsorb to suspended solids and sediment based upon the Koc values. Aqueous hydrolysis half-lives of fluvalinate at 25°C of 30 days at pH 3 and 6, and 1-2 hours at pH 9 have been reported. At 42°C hydrolysis half-lives of 35, 8 and 1 day were reported at pH 3, 6, and 9, respectively. Laboratory tests have shown that fluvalinate photodegrades rapidly (half-life of 1 day) in aqueous solutions (in Erlenmeyer flasks) exposed to sunlight. An agricultural water-sediment persistence study found that fluvalinate was undetectable after 15 days in the water-phase; however, it persisted beyond 20 days in the sediment. Volatilization from water surfaces is not expected to be an important fate process based upon this compound's estimated Henry's Law constant. An estimated BCF of 380 - 1979 suggests the potential for bioconcentration in aquatic organisms is high.

Occupational exposure to fluvalinate may occur through inhalation and dermal contact with this compound at workplaces where fluvalinate is produced or used. Monitoring data indicate that the general population may be exposed to fluvalinate *via* ingestion of some foods.

3.23.3. Toxicology and ecotoxicology

- Acute toxicity: unlikely to be hazardous (WHO)
- Carcinogenicity: not likely (EPA)
- Endocrine disruption: listed on Colborn and EU lists
- Reproductive and developmental toxicity: listed on CA Prop 65 Developmental Toxin, U.S. TRI Developmental Toxin, U.S. TRI Reproductive Toxin.

Terrestrial organisms

Mammals - Acute oral LD_{50} (mg/kg)		546	Rat	Moderate
Mammals - Short term dietary NOEL	(mg/kg)	1	Rat	High
				-
Birds - Acute LD_{50} (mg/kg)		> 2510	*Colinus virginianus*	Low
Birds - Short term dietary (LC_{50}/LD_{50}) mg kg bw^{-1} day^{-1}		> 455	*Colinus virginianus*	
Honeybees - Acute 48 hour LD50 (µg bee^{-1})		12	Contact	Moderate
Earthworms - Acute 14 day LC50 (mg/kg)		> 500	*Eisenia fetida*, corr	Moderate
Earthworms - Chronic 14 day NOEC, reproduction (mg/kg)		1.44	*Eisenia fetida*, corr	Moderate
Other soil macro-organisms - *e.g.* Collembola LR_{50} product per ha (mg kg^{-1})		9.6	*Folsomia candida*, 28 day acute NOEC mg/kg	-
Other arthropod (1) LR_{50} (g/ha)		0.049	48 hour *Aphidius rhopalosiphi*, adult	Harmful at 1 kg/ha
Other arthropod (2) LR_{50} (g/ha)		0.48	7 day *Typhlodromus pyri*	Harmful at 1 kg/ha
Soil micro-organisms		Nitrogen mineralisation: No significant effect Carbon mineralisation: No significant effect	Dose: 1.44 kg/ha, 28 days	-

Aquatic organisms

Fish - Acute 96 hour LC_{50} (mg/L)	0.000794	*Oncorhynchus mykiss*	High
Fish - Chronic 21 day NOEC (mg/L)	0.000064	*Pimephales promelas*, 35 days	-
Aquatic invertebrates - Acute 48 hour EC_{50} (mg/L)	0.0089	*Daphnia magna*	High
Aquatic invertebrates - Chronic 21 day NOEC (mg/L)	0.00021	*Daphnia magna*	

Sediment dwelling organisms - Chronic 28 day NOEC, static, water (mg/L)	0.00024	*Chironomus riparius*	High
Algae - Acute 72 hour EC_{50}, growth (mg/L)	> 42.0	*Scenedemus subspicatus*	Low

HC5= 0.064 (0.001 – 5.526) µg/L derived from freshwater organisms LC_{50} up to four days of exposure.

3.23.4. Environmental standards/regulations

Regulations

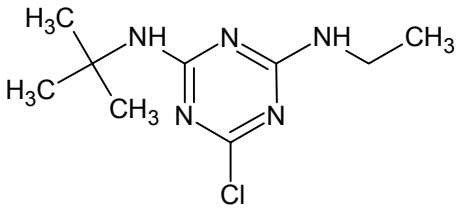
Registered for use in: 11 countries (AU, CA, NZ, SA, US).

3.23.5. Important user information

Users should pay attention to:

- the risk to aquatic organisms and non-target arthropods and ensure that conditions of use prescribe the application of adequate risk mitigation measures
- the specification of the technical material as commercially manufactured which must be confirmed and supported by appropriate analytical data. The test material used in the toxicity dossiers should be compared and verified against this specification of the technical material.

3.24. Terbuthylazine



3.24.1. Physico-chemical properties

Cas number	5915-41-3
Name (IUPAC)	N2-tert-butyl-6-chloro-N4-ethyl-1,3,5-triazine-2,4-diamine
Use class	Algaecide, herbicide, microbiocide
Chemical class	Triazine
Melting point	176°C
Vapour pressure	1.2×10^{-4} Pa at 25°C
Henry's law constant	1.64×10^{-6} Pa.m^3/mole at 25°C
Solubility in water	6.6 mg/L
Solubility (g/L) in organic solvents (at 20°C)	acetone: 41 toluene: 9.8 n-hexane: 0.41
Partition coefficient (log Kow)	3.4
Adsoprtion coefficient (Koc)	231
Dissociation constants (pKa)	1.9
Hydrolytic stability (DT_{50})	stable
Photostability in water (DT_{50})	stable
Aerobic soil half-life	75.1

3.24.2. Environmental fate

The production of terbuthylazine and use as a laboratory analytical standard may result in its release to the environment through various waste streams and its use as a herbicide will result in its direct release to the environment.

If released to air, a vapour pressure of 1.2×10^{-4} Pa at 25°C indicates terbuthylazine will exist in both the vapour and particulate phases in the ambient atmosphere. Vapour-phase terbuthylazine will be degraded in the atmosphere by reaction with photochemically-produced hydroxyl radicals; the half-life for this reaction in air is estimated to be 35 hrs. Particulate-phase terbuthylazine will be removed from the

atmosphere by wet and dry deposition. Terbuthylazine has been detected in ambient rain and snow samples. Direct photolysis is not an important fate due to weak absorption at wavelengths >290 nm.
If released to soil, terbuthylazine is expected to have only slight mobility based upon field observations. Although Koc values of 151-514 suggest moderate to low mobility, terbuthylazine interacts in soil to form strongly bound residues. Volatilization from moist soil surfaces is not expected to be an important fate process based upon an estimated Henry's Law constant of 1.64×10^{-6} Pa.m^3/mole at 25°C and results of soil volatilization tests. Some sensitized photodegradation may occur on soil surfaces exposed to sunlight. Terbuthylazine has been shown to degrade more rapidly in natural soil than in sterilized soil (22-27 *vs* 82 day half-lives). Field studies in biologically activate soil have reported terbuthylazine dissipation half-lives ranging from 6.5 to 149 days.

If released into water, terbuthylazine is expected to adsorb to suspended solids and sediment based upon the Koc. Volatilization from water surfaces is not expected to be an important fate process based upon this compound's Henry's Law constant. An estimated BCF of 25 suggests the potential for bioconcentration in aquatic organisms is low. Hydrolysis is not expected to be an important environmental fate process given half-lives of 73, 205 and 194 days at pH 5, 7 and 9, respectively. Sensitized photodegradation may have some importance in natural waters exposed to sunlight. In river, seawater and groundwater die-away tests, terbuthylazine had half-lives ranging from 44 to 196 days.

Occupational exposure to terbuthylazine may occur through inhalation and dermal contact with this compound at workplaces where terbuthylazine is produced or used. Workers may be exposed to terbuthylazine during applications in commercial/industrial settings. Monitoring data indicate that the general population may be exposed to terbuthylazine *via* ingestion of contaminated drinking water and dermal contact with this compound. People (including children) may be exposed while wading or swimming in treated ornamental ponds or fountains.

3.24.3. Toxicology and ecotoxicology

Terrestrial organisms

Mammals - Acute oral LD_{50} (mg/kg)	> 1000	Rat	Moderate
Mammals - Short term dietary NOEL (mg kg^{-1})	> 0.22	Rat, 2 year	High
			-
Birds - Acute LD_{50} (mg/kg)	> 1236	*Colinus virginianus*	Moderate
Birds - Short term dietary (LC_{50}/LD_{50}) mg kg bw^{-1} day^{-1}	> 395	*Anas platyrhynchos*	

Honeybees - Acute 48 hour LD_{50} ($\mu g\ bee^{-1}$)	> 22.6	Oral	Moderate
Earthworms - Acute 14 day LC_{50} (mg/kg)	> 141.7	*Eisenia fetida*, corr	Moderate
Other arthropod (1) LR_{50} g ha^{-1}	0.75	Mortality *Typhlodromus pyri*	Harmful at 1 kg/ha
Other arthropod (2) LR_{50} g ha^{-1}	0.75	Mortality *Aphidius rhopalosiphi*	Harmful at 1 kg/ha
Soil micro-organisms	Nitrogen mineralisation: No significant effect Carbon mineralisation: No significant effect	Dose: 10.9 mg/kg soil	-

Aquatic organisms

Fish - Acute 96 hour LC_{50} (mg/L)	2.2	*Oncorhynchus mykiss*	Moderate
Fish - Chronic 21 day NOEC (mg/L)	0.09	*Oncorhynchus mykiss*	-
Aquatic invertebrates - Acute 48 hour EC_{50} (mg/L)	21.2	*Daphnia magna*	Moderate
Aquatic invertebrates - Chronic 21 day NOEC (mg/L)	0.019	*Daphnia magna*	-
Aquatic crustaceans - Acute 96 hour LC_{50} (mg/L)	0.167	*Americamysis bahia*	Moderate
Sediment dwelling organisms - Chronic 28 day NOEC, static, water (mg/L)	0.5	*Chironomus riparius*	Moderate
Aquatic plants - Acute 7 day EC_{50}, biomass (mg/L)	0.0128	*Lemna gibba*	Moderate
Algae - Acute 72 hour EC_{50}, growth (mg/L)	0.012	*Pseudokirchneriella subcapitata*	Moderate

HC5 = 1895 (408 – 8811) µg/L derived from LC_{50} of aquatic animals exposed up to four days.

3.24.4. Environmental standards/regulations

Water standards and criteria
Australian Drinking Water Guideline: 10 µg/L

Regulations
Registered for use in: Nine countries (including AU, NZ, SA, US).

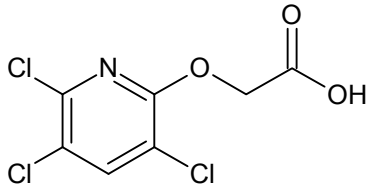
3.24.5. Important user information

Users should pay attention to

- the protection of groundwater, when the active substance is applied in regions with vulnerable soil and/or climatic conditions;
- the long-term risk and the risk from secondary poisoning for mammals and the risk for earthworms.

Conditions of use shall include risk mitigation measures and monitoring programmes should be initiated to verify potential groundwater contamination in vulnerable zones, where appropriate.

3.25. Triclopyr



3.25.1. Physico-chemical properties

Cas number	55335-06-3
Name (IUPAC)	3,5,6-trichloro-2-pyridyloxyacetic acid
Use class	Herbicide
Chemical class	Chloropyridinyl
Appearance	Fluffy, colourless solid
Boiling point	150.5
Relative density	1.85
Vapour pressure	1.68×10^{-4} Pa at at 25°C
Henry's law constant	9.8×10^{-5} Pa.m^3/mole
Solubility in water (at 25°C)	440 mg/L
Solubility (g/L) in organic solvents (at 20°C)	acetone: 581 acetonitrile: 92.1 hexane: 0.09 toluene: 19.2 dichloromethane: 24.9 methanol: 665
Dissociation constants (pKa)	2.68
Partition coefficient (log Kow)	-0.42 (pH 5), -0.45 (pH 7), -0.96 (pH 9)
Adsoprtion coefficient (Koc)	1.5 - 134
Hydrolytic stability (DT_{50})	84 d at pH 5 and 25°C, 26 d at pH 5 and 35°C, 8.7 days at pH 7 and 25°C, 2.3 d at pH 7 and 35°C, 0.3 d at pH 9 and 25 °C, 0.06 d at pH 9 and 35°C
Photostability in water (DT_{50})	0.1 d
Aerobic soil half-life	8-39d
Anaerobic soil half-life	1300 d

3.25.2. Environmental fate

The production of triclopyr may result in its release to the environment through various waste streams and its use as a herbicide will result in its direct release to the environment.

If released to air, a vapour pressure of 1.68×10^{-4} Pa at 25°C indicates triclopyr will exist in both the vapour and particulate phases in the ambient atmosphere. Vapour-phase triclopyr will be degraded in the atmosphere by reaction with photochemically-produced hydroxyl radicals; the half-life for this reaction in air is estimated to be 3.3 days. Particulate-phase triclopyr will be removed from the atmosphere by wet and dry deposition. Triclopyr undergoes photodecomposition with a half-life of <12 hours.

If released to soil, triclopyr is expected to have high to very high mobility based upon Koc's ranging from 1.5 to 134. Volatilization from moist soil surfaces is not expected to be an important fate process based upon an estimated Henry's Law constant of 9.8×10^{-5} Pa.m^3/mole. Under aerobic conditions, triclopyr biodegrades with half-lives of 8 and 18 days in silty clay loam and silt loam soils, respectively. Triclopyr is persistent under anaerobic conditions with a half-life of approx 1,300 days.

If released into water, triclopyr is not expected to adsorb to suspended solids and sediment based upon its range of Koc values. Triclopyr degraded slowly in a soil:water system incubated aerobically; the half-life is 142 days. Volatilization from water surfaces is not expected to be an important fate process based upon this compound's estimated Henry's Law constant. An estimated bioconcentration factor of 3 suggests the potential for bioconcentration in aquatic organisms is low. Hydrolysis is not expected to be an important process under environmental conditions because of the lack of hydrolyzable functional groups.
Occupational exposure to triclopyr may occur through dermal contact with this compound at workplaces where triclopyr is produced or used.

3.25.3. Toxicology and ecotoxicology

- Acute toxicity: Slightly hazardous (WHO), no consensus (EPA)
- Carcinogenicity: not listed (IARC), unclassifiable (EPA)
- Endocrine disruption: not listed
- Reproductive and environmental toxicity: not listed

Terrestrial organisms

Mammals - Acute oral LD_{50} (mg/kg)	630	Rat	Moderate
Mammals - Short term dietary NOEL (mg kg^{-1})	3	Rat, 2 year	High

Birds - Acute LD_{50} (mg/kg)	1698	*Anas platyrhynchos*	Moderate
Birds - Short term dietary (LC_{50}/LD_{50}) mg kg feed^{-1}	> 5620	*Anas platyrhynchos*	-

Aquatic organisms

Organism group	Acute toxicity range
Amphibians	Not Acutely Toxic
Fish	Slight to Moderate Toxicity
Zooplankton	Not Acutely Toxic

Fish - Acute 96 hour LC_{50} (mg/L)	117	*Oncorhynchus mykiss*	Low
Fish - Chronic 21 day NOEC (mg/L)	46.3	Unknown species	-
Aquatic invertebrates - Acute 48 hour EC_{50} (mg/L)	> 131	*Daphnia magna*	Low
Aquatic invertebrates - Chronic 21 day NOEC (mg/L)	48.5	Unknown species	-
Sediment dwelling organisms - Chronic 28 day NOEC, static, water (mg/L)	23.0	*Chironomus riparius*	Low
Aquatic plants - Acute 7 day EC_{50}, biomass (mg/L)	0.8	*Lemna gibba*	Moderate
Algae - Acute 72 hour EC_{50}, growth (mg/L)	75.8	*Raphidocelis subcapitata*	Low
Algae - Chronic 96 hour NOEC, growth (mg/L)	8	Unknown species	Low
Honeybees - Acute 48 hour LD_{50} (µg bee^{-1})	> 100	Contact	Moderate
Earthworms - Acute 14 day LC_{50} (mg/kg)	> 521	*Eisenia fetida*, corr	Moderate

HC5 = 1314 (235 – 7347) µg/L derived from LC_{50} of aquatic animals exposed up to four days.

3.25.4. Environmental standards/regulations

Water standards and criteria

France – Water quality guideline for the protection of aquatic life – PNEC: 5.8 µg/L

Regulations

Registered for use in: 20 countries (including AU, EU, NZ, SA, US)

Listed for concern: not in the Groundwater Protection List (or approved by Department of Pesticide Regulation).

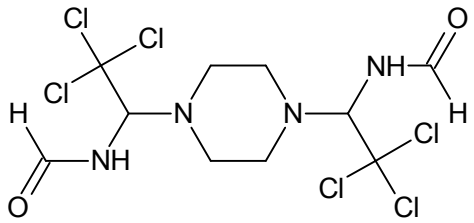
3.25.5. Important user information

Users must pay particular attention to:

- the protection of groundwater under vulnerable conditions. Conditions of authorisation should include risk mitigation measures and monitoring programmes should be initiated in vulnerable zones, where appropriate;
- the safety of operators and ensure that conditions of use prescribe the application of adequate personal protective equipment;
- the protection of birds, mammals, aquatic organisms and non-target plants.

Conditions of authorisation should include risk mitigation measures, where appropriate.

3.26. Triforine



3.26.1. Physico-chemical properties

Cas number	26644-46-2 / 37273-84-0
Name (IUPAC)	*N*,*N*'-{piperazine-1,4-diylbis[(trichloromethyl)methylene]}diformamide
Use class	Fungicide, insecticide
Chemical class	Piperazine
Appearance	White to light brown crystals
Boiling point	155°C
Relative density	1.55
Vapour pressure	2.67×10^{-5} Pa at 25°C
Henry's law constant	3.85×10^{-4} Pa.m^3/mole
Solubility in water (at 25°C)	9-30 mg/L
Solubility (g/L) in organic solvents	dimethylformamide: 330 acetone: 11 methanol: 10
Dissociation constants (pKa)	10.6
Partition coefficient (log Kow)	2.2
Adsoprtion coefficient (Koc)	200 - 527
Hydrolytic stability (DT_{50})	2 – 3d (pH dependant)
Photostability in water (DT_{50})	0.2 d
Aerobic soil half-life	19 d

3.26.2. Environmental fate

The production of triforine may result in its release to the environment through various waste streams and its use as a fungicide on fruit, ornamentals, vegetables, and cereals will result in its direct release to the environment.

If released to air, a vapour pressure of 2.67×10^{-5} Pa at 25°C indicates triforine will exist in both the vapour and particulate phases in the ambient atmosphere. Vapour-

phase triforine will be degraded in the atmosphere by reaction with photochemically-produced hydroxyl radicals; the half-life for this reaction in air is estimated to be 6 hrs. Particulate-phase triforine will be removed from the atmosphere by wet and dry deposition.
If released to soil, triforine is expected to have very moderate mobility based upon a Koc range of 200 - 527. Volatilization from moist soil surfaces is not expected to be an important fate process based upon an estimated Henry's Law constant of 3.85×10^{-4} $Pa.m^3/mole$.

If released into water, triforine is not expected to adsorb to suspended solids and sediment based upon the Koc. Volatilization from water surfaces is not expected to be an important fate process based upon this compound's estimated Henry's Law constant. An estimated bioconcentration factor of 10 suggests the potential for bioconcentration in aquatic organisms is low. A hydrolysis half-life of 2 to 3 days has been reported. Triforine decomposes in aqueous solution exposed to UV or daylight.

Occupational exposure to triforine may occur through inhalation and dermal contact with this compound at workplaces where triforine is produced or used. Monitoring data indicate that the general population may be exposed to triforine *via* ingestion of food and dermal contact with consumer products containing triforine.

3.26.3. Toxicology and ecotoxicology

- Acute toxicity: unlikely to be hazardous (WHO), slightly toxic (EPA)
- Carcinogenicity: suggestive (EPA)
- Endocrine disruption: not listed
- Reproductive and developmental toxicology: yes (CA, US)

Terrestrial organisms

Mammals - Acute oral LD_{50} (mg/kg)	> 16000	Rat	Low
Mammals - Short term dietary NOEL (ppm diet)	200	Rat, 2 year	-
Birds - Acute LD_{50} (mg/kg)	5000	*Colinus virginianus*	Low
Honeybees - Acute 48 hour LD_{50} (µg bee^{-1})	10	Oral	Moderate
Earthworms - Acute 14 day LC_{50} (mg/kg)	1000		Moderate
Other arthropod (1) LR_{50} g ha^{-1}	Harmless	Dose: 600 g ha^{-1} *Typhlodromus pyri*	Harmless
Other arthropod (2) LR_{50} g ha^{-1}	Harmless	Dose: 600 g ha^{-1} *Chrysoperla carnea*	Harmless

Aquatic organisms

Fish - Acute 96 hour LC_{50} (mg/L)	1000	*Salmonidae*	Low
Aquatic invertebrates - Acute 48 hour EC_{50} (mg/L)	25	*Daphnia magna*	Moderate
Algae - Acute 72 hour EC_{50}, growth (mg/L)	380	*Scenedemus subspicatus*	Low

The HC5 calculated at 476 µg/L (no 95% CI) derived from LC_{50} of fish exposed up to four days, has a very low reliability due to the low number of studies.

3.26.4. Environmental standards/regulations

Regulations

Registered for use in: Seven countries (AU, CA, NZ, SA, US)
Listed for concern: not in the Groundwater Protection List (or approved by Department of Pesticide Regulation).

3.26.5. Important user information

N/A

4. REFERENCES

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5. APPENDICES

Appendix 1. Guidelines and databases used for the review of 26 pesticides on behalf of Nelson City Council (NCC).

Pesticide Action Network (PAN) pesticide database	www.pesticideinfo.org
Rotterdam Convention	www.pic.int
European Union Pesticides database	http://ec.europa.eu/sanco_pesticides/
ToxNet	http://toxnet.nlm.nih.gov
AgriTox	www.agritox.anses.fr
United States National Pesticide Information Center	http://npic.orst.edu
United States Integrated Pest Management Centers (*e.g.* North Central)	www.ncipmc.org
Canadian Environmental Quality Guidelines	http://st-ts.ccme.ca/
European Chemicals Agency	http://echa.europa.eu/
Australian and New Zealand Guidelines	www.environment.gov.au/water/publications/quality/index.html

Appendix 2. Summary of category parameters considered for ranking the reviewed pesticides.

Agri-chemical	Function	Area for use	Kow	Koc	GUS‡	BCF	Half-life (days) water hydrolysis	Half-life in soil (days)	HC5[1] (µg/L)	Environmental ranking	Notes[2]
Picloram	Herbicide	All areas within parks and reserves, EXCEPT in or near waterways	-1.92	13	6.03	31	stable	82.8	5135		approved by DPR but not in GWL
Triclopyr	Herbicide	All areas within parks and reserves, adjacent but NOT in waterways	-0.45	134	3.69	n/r	8.7	39	1314		
Mecoprop	Herbicide	All areas within parks and reserves, EXCEPT in or near waterways	-0.19	47	2.29	3	stable	8.2	3353		Precautionary (lack of Ecotox data) in the GWL of PDR, Banned in Thailand
Dicamba	Herbicide	All areas within parks and reserves, EXCEPT in or near waterways	-1.88	34	1.75	15	30	10	2898		in the GWL of DPR
Dichlorprop	Herbicide	All areas within parks and reserves, EXCEPT in or near waterways	3.4	129	2.39	3	stable	14	117		in the GWL of DPR
2,4-D	Herbicide	All areas within parks and reserves, EXCEPT in or near waterways	-0.83	136	1.62	1	730	34	9193		Banned in Norway, in the GWL of DPR

[1] HC5 underlined are to be used with caution due to either the absence or their wide 95% confidence interval.
[2] The rank is set to yellow when either the chemicals is either banned in any country, or in the GWL of DPR, or when not enough data are available (precautionary) to determine the ranking

Agri-chemical	Function	Area for use	Kow	Koc	GUS‡	BCF	Half-life (days) water hydrolysis	Half-life in soil (days)	HC5[1] (µg/L)	Environmental ranking	Notes[2]
Ethofumesate	Herbicide	Only on Sportsfields, NOT in or near waterways	2.7	187	3.19	24	stable	93	4683		in the GWL of DPR
Glyphosate	Herbicide	All areas within parks and reserves, including near waterways	2.76	6920	-0.49	0.63	stable	96	4436		Carcinogenicity reported
Metsulfuron	Herbicide	Only in Conservation and Landscape reserves, EXCEPT in or near waterways	-1.7	57	n/r	17	stable	n/r	75282		Precautionary (lack of Ecotox data)
Terbuthylazine	Herbicide	All areas within parks and reserves, EXCEPT in or near waterways	3.4	231	3.07	25	stable	75.1	1894		in the GWL of DPR
Haloxyfop	Herbicide	All areas within parks and reserves, EXCEPT in or near waterways	n/r	75	2.03	n/r	stable	55	n/r		Precautionary (lack of data)
MCPA	Herbicide	All areas within parks and reserves, EXCEPT in or near waterways	-0.81	74	2.94	1	stable	24	284		Banned in Thailand
MCPB	Herbicide	All areas within parks and reserves, EXCEPT in or near waterways	1.32	130	1.66	3	stable	7	1324		Banned in Thailand
Paclobutrazole	Herbicide	Only on Sportsfields, NOT in or near waterways	3.2	400	3.44	n/r	stable	112	10511		

Agri-chemical	Function	Area for use	Kow	Koc	GUS‡	BCF	Half-life (days) water hydrolysis	Half-life in soil (days)	HC5[1] (µg/L)	Environmental ranking	Notes[2]
Copper Hydroxide	Fungicide	Croquet lawn/Golf lawns/ sportsfields and roses. NOT in or near waterways	0.44	12000	-0.32	n/r	stable	10000	3.15		
Lime Sulphur	Fungicide	All areas within parks and reserves, EXCEPT in or near waterways	n/r	n/r	n/r	n/r	n/r	730	3041		
Azoxystrobin	Fungicide	Croquet lawn/Golf lawns/ sportsfields. NOT in or near waterways	2.76	589	2.6	21	stable	113	77		in the GWL of DPR
Mancozeb	Fungicide	Croquet lawn/Golf lawns/ sportsfields. NOT in or near waterways	1.33	998	-1	4	0.1	2	152		approved by DPR but not in GWL
Triforine	Fungicide	All areas within parks and reserves, EXCEPT in or near waterways	2.2	527	1.63	n/r	3	19	476		approved by DPR but not in GWL
Propiconazole	Fungicide	Croquet lawn/Golf lawns/ sportsfields. NOT in or near waterways	3.75	656	1.51	146	85	214	471		
Chlorothalonil	Fungicide	Croquet lawn/Golf lawns/ sportsfields and roses. NOT in or near waterways	2.94	1790	0.7	264	stable	32	10		in the GWL of DPR
Tau-fluvalinate	Insecticide	All areas within parks and reserves, EXCEPT in or near waterways	7	135000	-0.76	1979	22.5	135	0.064		

Agri-chemical	Function	Area for use	Kow	Koc	GUS‡	BCF	Half-life (days) water hydrolysis	Half-life in soil (days)	HC5[1] (µg/L)	Environmental ranking	Notes[2]
Methiocarb	Insecticide	Only used at Trafalgar Park, NOT in or near waterways	2.92	660	0.17	75	24	64	15.6		in the GWL of DPR
Chlorpyrifos	Insecticide	Croquet lawn/Golf lawns/ sportsfields. NOT in or near waterways	4.7	31000	0.15	1000	62	30.5	0.15		in the EU-Water framework directive priority list (2001) Banned in Saudi Arabia
Clofentezine	Insecticide	All areas within parks and reserves, EXCEPT in or near waterways	3.1	n/r	n/r	n/r	1.4	131	10.4		
Calteryx	Insecticide	Croquet lawn/Golf lawns/ sportsfields. NOT in or near waterways	2.76	464	4.22	31	30	523	n/r		

Notes:

- Kow: Partition coefficient, is a measure of how a chemical will distribute between two immiscible solvents: water (a polar solvent) and octanol (a relatively non-polar solvent).
- Koc: Adsorption coefficient is a measure of how strongly a chemical adheres to soil in preference to remaining dissolved in water.
- BCF: Bioconcentration factor, describes the accumulation of toxicants (*i.e.* from the water to the organism), for aquatic animals.
- GUS: Groundwater Ubiquity Score, an indicator of a chemical potential for leaching into groundwater (‡ not taken into account for the ranking. Refer to Definitions table for the leaching likelihood).
- HC5: A hazardous substance for 5% of the species population (95% protection level). Derived from aquatic animals' data.
- P: Precautionary ranking (lack of data)
- R: Regulatory ranking (banned or pending approval)
- Greyed cases: non-reported values replaced by intermediate score
- Precautionary from vertebrate studies (non- reported in the table)
- GWL: Groundwater Protection List
- DPR: Department of Pesticide Regulation of California
- n/r: not reported.