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Calculator: Elisabeth Harrahy, Ph.D.

SECONDARY VALUES FOR DICAMBA (CAS No. 1918-00-9)

A search was conducted for information on the chemical properties and toxicity of dicamba to human health and to fish and aquatic life using the following databases and search engines: ECOTOX (toxicity to fish and aquatic life), IRIS (Integrated Risk Information System; toxicity to human health), CHEMFATE (environmental fate), BIODEG (degradation), HSDB (Hazardous Substances Data Bank), CCRIS (Chemical Carcinogenesis Research Info System), ATSDR ToxFAQs (Agency for Toxic Substances and Disease Registry chemical fact sheets), and EXTOXNET (Extension Toxicology Network's pesticide information project). This search yielded some useful information on dicamba's properties and toxicity.

Fish and Aquatic Life Secondary Values

To derive an acute toxicity criterion for fish and aquatic life, acute toxicity test results are required for at least one species in each of eight different families. Specific requirements and the data available to meet these requirements are found in Table 1. Following a search for information on the toxicity of dicamba to fish and other aquatic life, it was determined that data are available to meet five out of the eight requirements. Because data are available for a Daphnid species, it was possible to calculate a secondary acute value for dicamba.

Cold Water

To calculate a secondary acute value (SAV), the lowest genus mean acute value (GMAV) in the database is divided by the secondary acute factor (SAF; an adjustment factor corresponding to the number of satisfied requirements).

SAF for five out of eight requirements met = 6.1
Lowest GMAV = 23,780.44 µg/L (*Gammarus fasciatus*)

SAV = GMAV/SAF
= 23,780.44 µg/L / 6.1
= 3,898.43 µg/L

No chronic data are currently available for dicamba which meet acceptability requirements; therefore, a secondary chronic value (SCV) may be calculated using default ratios only.

SACR (secondary acute-chronic ratio) = Geometric mean of three species mean acute-chronic ratios (SMACRs).

SMACR 1 = 18 (default)
SMACR 2 = 18 (default)

SMACR 3 = 18 (default)

SACR = geometric mean of 18, 18, and 18 = 18

SCV = SAV/SACR
= 3,898.43 µg/L / 18
= 216.58 µg/L

So for cold water designated waters, the secondary acute value is 3,898 µg/L and the secondary chronic value is 217 µg/L for dicamba.

<u>Warm Water Sportfish, Warm Water Forage Fish, Limited Forage Fish, Limited Aquatic Life</u>

Because the lowest GMAV is for an invertebrate (*Gammarus fasciatus*), and because invertebrates will not drop out of the database for any of the remaining water body use classifications, secondary values calculated for cold water designated waters will also apply for warm water sportfish, warm water forage fish, limited forage fish and limited aquatic life designated waters.

Table 1. Requirements for calculation of an acute toxicity criterion for protection of aquatic life for dicamba, and corresponding acute toxicity data.

Species Name	Common Name	Duration/ Endpoint	Value µg/L	Reference #[a]	Source
1. At least one salmonid fish in the family Salmonidae, in the class Osteichthyes.					
Oncorhynchus clarki	**cutthroat trout**	**96-h/LC50**	**>50,000**	**7**	**AQUIRE**
Oncorhynchus mykiss	**rainbow trout**	**96-h/LC50**	**28,000**	**1**	**AQUIRE**
Oncorhynchus mykiss	**rainbow trout**	**96-h/LC50**	**135,400**	**2**	**AQUIRE**
Oncorhynchus mykiss	**rainbow trout**	**96-h/LC50**	**153,000**	**2**	**AQUIRE**
Oncorhynchus mykiss	**rainbow trout**	**96-h/LC50**	**130,000**	**2**	**AQUIRE**
Oncorhynchus mykiss	**rainbow trout**	**96-h/LC50**	**28,000**	**3**	**AQUIRE**
Species Mean Acute Value (SMAV) = 73,267.93					
2. At least one non-salmonid fish from another family in the class Osteichthyes, preferably a commercially or recreationally important warmwater species.					
Lepomis macrochirus	**bluegill**	**96-h/LC50**	**>50,000**	**1**	**AQUIRE**
Lepomis macrochirus	**bluegill**	**96-h/LC50**	**135,300**	**2**	**AQUIRE**
Lepomis macrochirus	**bluegill**	**96-h/LC50**	**180,000**	**2**	**AQUIRE**
SMAV = 106,758.78					
3. At least one planktonic crustacean (e.g., cladoceran, copepod).					
Daphnia magna	**water flea**	**48-h/EC50**	**>100,000**	**4**	**AQUIRE**
Daphnia magna	**water flea**	**48-h/EC50**	**>100,000**	**1**	**AQUIRE**
Daphnia magna	**water flea**	**48-h/EC50**	**110,700**	**2**	**AQUIRE**
Daphnia magna	**water flea**	**48-h/EC50**	**750,000**	**2**	**AQUIRE**
SMAV = 169,747.04					
4. At least one benthic crustacean (e.g., ostracod, isopod, amphipod, crayfish).					
Gammarus fasciatus	**scud**	**96-h/LC50**	**>100,000**	**1**	**AQUIRE**

Gammarus fasciatus	**scud**	**96-h/LC50**	**>100,000**	**3**	**AQUIRE**
Gammarus fasciatus	**scud**	**96-h/LC50**	**3,900**	**6**	**AQUIRE**
Gammarus fasciatus	**scud**	**96-h/LC50**	**3,900**	**2**	**AQUIRE**
Gammarus fasciatus	**scud**	**96-h/LC50**	**>50,000**	**1**	**AQUIRE**

Normally some of these values would be excluded from the database because they are so highly variable. However, three of the results (majority) are near the LC50s for other substances while two (minority) are much tighter. It's not clear which results should be excluded based on comparisons with other species, so for now the SMAV shall be based on all five results. SMAV = 23,780.44

5. At least one insect (e.g., mayfly, dragonfly, damselfly, stonefly, caddisfly, mosquito, midge).

6. At least one fish or amphibian from a family in the phylum Chordata not already represented in one of the other subdivisions.

Gambusia affinis	**Western mosquitofish**	**96-h/LC50**	**465,000**	**5**	**AQUIRE**

7. At least one organism from a family in a phylum other than Arthropoda or Chordata (e.g., Rotifera, Annelida, Mollusca).

8. At least one organism from a family in any order of insect or any other phylum not already represented in subdivisions 1 through 7.

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[1]Johnson, W.W. and M.T. Finley. 1980. Handbook of acute toxicity of chemicals to fish and aquatic invertebrates. Resource Publication 137, U.S. Department of Interior, U.S. Fish and Wildlife Service, Washington, D.C. 98 pp.
[2]Office of Pesticide Programs. 2000. Environmental Effects Database (EEDB). Environmental Fate and Effects Division, U.S. EPA, Washington, D.C.
[3]Mayer, F.L.J. and M.R. Ellersieck. 1986. Manual of acute toxicity: Interpretation and data base for 410 chemicals and 66 species of freshwater animals. Resource Publication No. 160. U.S. Department of Interior, U.S. Fish and Wildlife Service, Washington, D.C. 505 pp.
[4]Sanders, H.O. 1970. Toxicities of some herbicides to six species of freshater crustaceans. Journal of Water Pollution Control Federation 24(8):1544-1550.
[5]Johnson, C.R. 1978. Herbicide toxicities in the mosquito fish, *Gambusia affinis*. Proc. R. Soc. Queensl. 89:25-27.
[6]Sanders, H.O. 1969. Toxicity of pesticides to the crustacean *Gammarus lacustris*. Technical Paper No. 25, Bureau of Sports Fisheries and Wildlife, U.S. Fish and Wildlife Service, U.S. Department of Interior, Washington, D.C. 18 pp.
[7]Woodward, D.F. 1982. Acute toxicity of mixtures of range management herbicides to cutthroat trout. Journal of Range Management 35(4):539-540.

HUMAN HEALTH

To calculate a criteria or secondary value for the protection of human health, it is first necessary to determine if the substance has been shown to be carcinogenic (which will result in the calculation of a human cancer criteria or secondary value) or not (which will result in the calculation of a human threshold criteria or secondary value). The carcinogenicity of dicamba has not yet been classified because of inadequate data (U.S. EPA's IRIS database). Because an oral reference dose and a log octanol water partition coefficient are available, a human threshold secondary value can be calculated for dicamba.

There are several steps to calculating a human threshold secondary value: 1) calculation of the fraction of freely dissolved chemical; 2) calculation of the "baseline BAF"; 3) calculation of the "human health BAF"; and 4) calculation of the human threshold secondary value.

1) Calculation of the freely-dissolved fraction = f_{fd}

Given a standard dissolved organic carbon (DOC) concentration of 0.000002 Kg/L and a particulate organic carbon (POC) concentration of 0.00000004 Kg/L in water, the equation

$$f_{fd} = 1/\{1 + [(DOC)(K_{ow})/10] + [(POC)(K_{ow})]\}$$

can be reduced to:

$$= 1/\{1 + [(0.00000024\ Kg/L)(K_{ow})]\}$$

A log K_{ow} of 2.21 (K_{ow} of 162.1810) has been published for dicamba (National Institutes of Health, Hazardous Substance Database).

$$f_{fd} = 1/\{1 + [(0.00000024\ Kg/L)(162.1810)]\}$$

$$= 1/1.000039$$

$$\mathbf{= 1.0000}$$

2) Calculation of the baseline BAF

The baseline BAF is calculated according to the equations contained in 40 CFR part 132 (Final Water Quality Guidance for the Great Lakes System), Appendix B, using BAF data that was collected in one of four ways (listed in order of most preferred to least preferred):

a) a measured BAF from a field study
b) a predicted BAF based on field-measured BSAFs
c) a predicted BAF using a laboratory-measured bioconcentration factor (BCF) and a food chain multiplier (FCM)
d) a predicted BAF using a K_{ow} and a FCM

Currently, there are no BAFs, BSAFs, or BCFs available for dicamba; therefore, the baseline BAF was calculated using the K_{ow} and a food chain multiplier (method d above).

Given dicamba's log K_{ow} of 2.21 (K_{ow} of 162.1810), the FCMs (taken from table B-1 in GLI) were interpolated to be 1.007 for trophic level 3 (warm waters) and 1.001 for trophic level 4 (cold waters).

a) Cold Water

Baseline BAF = (FCM)(Kow)

= (1.001)(162.1810)

= 162.3432

b) Warm Waters

Baseline BAF = (FCM)(Kow)

= (1.007)(162.1810)

= 163.3163

3) Calculation of the human health BAF

a) Cold Water

BAF^{HH}_{TL4} = {[(baseline BAF)(0.044)] + 1} (f_{fd})

where

BAF^{HH}_{TL4} = Human health BAF for trophic level 4 (cold water)

baseline BAF = the baseline BAF (for cold waters) calculated in 2)

0.044 = fraction lipid value for cold water fish and aquatic life communities

f_{fd} = fraction freely dissolved

BAF^{HH}_{TL4} = {[(162.3432)(0.044)] + 1} (1.0000)

= **8.1431**

b) Warm Waters

BAF^{HH}_{TL3} = {[(baseline BAF)(0.013)] + 1} (f_{fd})

where

BAF^{HH}_{TL3} = Human health BAF for trophic level 3 (warm waters)

baseline BAF = the baseline BAF (for warm waters) calculated in 2)

0.013 = fraction lipid value for warm water fish and aquatic life communities

f_{fd} = fraction freely dissolved

$BAF^{HH}_{TL3} = \{[(163.3163)(0.013)] + 1\} (1.0000)$

= **3.1231**

4) Calculation of the human threshold secondary value

Human Threshold Secondary Value = $[(ADE)(70\ Kg)(RSC)]/[W_H + (F_H)(BAF)]$

where

ADE = acceptable daily exposure (= oral reference dose, or RfD; = 0.03 mg/Kg/day for dicamba (IRIS 2003))

70 Kg = average weight of an adult

RSC = relative source contribution to account for other routes of exposure (= 0.8 in the absence of other data)

W_H = average per capita daily water consumption (= 2 L/d for public water supplies, and 0.01 L/d for non-public water supplies)

F_H = average consumption of sport-caught fish in Wisconsin (= 0.02 Kg/d)

BAF = appropriate (cold or warm water) human health BAF calculated in 3.

a) Public Water Supply/Cold Water

Human Threshold Secondary Value = $[(ADE)(70\ Kg)(RSC)]/[W_H + (F_H)(BAF)]$

= [(0.03 mg/Kg/d)(70 Kg)(0.8)]/[**2** L/d + (0.02 Kg/d)(8.1431 L/Kg)]

= 0.7767 mg/L

= 776.7 µg/L

b) Public Water Supply/Warm Water Sportfish

Human Threshold Secondary Value = [(ADE)(70 Kg)(RSC)]/[W_H + (F_H)(BAF)]

= [(0.03 mg/Kg/d)(70 Kg)(0.8)]/[**2** L/d + (0.02 Kg/d)(3.1231 L/Kg)]

= 0.8145 mg/L

= 814.5 µg/L

c) Non-Public Water Supply/Cold Water

Human Threshold Secondary Value = [(ADE)(70 Kg)(RSC)]/[W_H + (F_H)(BAF)]

= [(0.03 mg/Kg/d)(70 Kg)(0.8)]/[**0.01** L/d + (0.02 Kg/d)(8.1431 L/Kg)]

= 9.7166 mg/L

= 9,716.6 µg/L

d) Non-Public Water Supply/Warm Waters (Warm Water Sportfish, Warm Water Forage Fish, and Limited Forage Fish designated waters)

Human Threshold Secondary Value = [(ADE)(70 Kg)(RSC)]/[W_H + (F_H)(BAF)]

= [(0.03 mg/Kg/d)(70 Kg)(0.8)]/[**0.01** L/d + (0.02 Kg/d)(3.1231 L/Kg)]

= 23.1724 mg/L

= 23,172.4 µg/L

e) Non-Public Water Supply/Limited Aquatic Life

Note: The Limited Aquatic Life classification applies to water bodies with no (or very few) fish present. Therefore, calculation of a human health threshold value for water bodies with this classification does not include a human health BAF since it is assumed that humans will not be exposed to dicamba through consumption of fish in these areas.

Human Threshold Secondary Value = $[(ADE)(70\ Kg)(RSC)]/[W_H + (F_H)(BAF)]$

$= [(0.03\ mg/Kg/d)(70\ Kg)(0.8)]/[\mathbf{0.01}\ L/d + (0)]$

= 168 mg/L

= 168,000 µg/L

Chemical	CAS #	Category	Type of Secondary Value	Water Body Classification	Value (µg/L)
Dicamba	1918-00-9	Fish and Aquatic	Acute	Cold, WWSF, WWFF, LFF, LAL	3,898
Dicamba	1918-00-9	Fish and Aquatic	Chronic	Cold, WWSF, WWFF, LFF, LAL	217
Dicamba	1918-00-9	Human Health	Human Threshold	Public Water Supply/Cold	777
Dicamba	1918-00-9	Human Health	Human Threshold	Public Water Supply/WWSF	814
Dicamba	1918-00-9	Human Health	Human Threshold	Non-Public Water Supply/Cold	9,717
Dicamba	1918-00-9	Human Health	Human Threshold	Non-Public Water Supply/WWSF, WWFF, LFF	23,172
Dicamba	1918-00-9	Human Health	Human Threshold	Non-Public Water Supply/LAL	168,000

Cold = cold water designated water bodies
WWSF = warm water sportfish designated water bodies
WWFF = warm water forage fish designated water bodies
LFF = limited forage fish designated water bodies
LAL = limited aquatic life designated water bodies (includes wetlands)