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Environmental Toxicities and Properties of Common Herbicides

Pesticide hazards include the possibility of adverse effects on nontarget organisms. Adverse effects can result from drift, surface runoff, or direct contact with pesticide compounds. The risks to humans, wildlife, and endangered or desirable plant species should be considered before applying a pesticide. Chapter 16, "Toxicity of Herbicides," is a reference for human toxicity and exposure; Chapter 18 is primarily concerned with exposure of fish and wildlife.

The risks associated with pesticide use should be considered in light of species tolerance and amount of exposure. The amount of exposure may be mitigated by such factors as the size of the area treated, pesticide placement and potential movement, time and rate of application, and half-life of the compound. The information in this chapter and the data in Table 1 are provided as a guide for determining the potential environmental risks of pesticide application. The information in the table is taken from studies conducted by manufacturers to fulfill requirements for pesticide registration. Because many of these studies were completed prior to the implementation of current standards, some data may be missing, incomplete, or reported in nonstandard units.

How to Use the Table

LC_{50}, the lethal concentration of a pesticide, is the concentration that will kill 50 percent of test animals. The LC_{50} values of various herbicides for fish (bluegill and rainbow trout) are shown in Table 1. For fish, the test consists of treating tank water with pesticide for a specified period, typically 96 hours, although periods of 8 hours may be used for particularly toxic pesticides. LD_{50} is the dosage that will kill 50 percent of test animals when administered through oral routes, usually in food or water. For mallard ducks, 5- to 8-day feeding trials are conducted. The LD_{50} values for ducks refer to either pesticide-treated water (usually reported as parts per million, ppm) or pesticide-treated food (usually reported in milligrams of chemical per kilogram of body weight, mg/kg).

When interpreting the data from these studies, note that compounds with very small LC_{50} or LD_{50} values have very high toxicities (a small amount may be very toxic). A concentration of 1 ppm is equivalent to 2.7 pounds of pesticide in 1 acre–foot of water. A herbicide with an LD_{50} or LC_{50} value that is between 100 and 2,000 ppm is considered to be of moderate toxicity. A herbicide with an LD_{50} or LC_{50} greater than 2,000 ppm is of low toxicity, and one with a value less than 100 is considered highly toxic. Some compounds were reported in the literature as low, moderate, toxic, or very toxic, without numerical data.

The level of species susceptibility to a pesticide may vary due to other stresses an organism may be undergoing, avoidance of the pesticide where possible, and factors such as age and sex. The susceptibility of other species not listed in the table may vary from quoted figures by a factor of 100 or more. In areas where a potential hazard to fish and wildlife exists, the following is recommended: (1) select a herbicide with the lowest possible toxicity that is effective for controlling the targeted weeds; (2) limit the size of the treated area as much as possible—for example, by banding or spot-treating; (3) make the application at the minimum effective rate; and (4) time the application to occur when the potential for surface-water runoff is minimal. Crop management measures that reduce runoff, such as reduced tillage, may reduce herbicide loss,

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The information in this chapter is provided for educational purposes only. Product trade names have been used for clarity, but reference to trade names does not imply endorsement by the University of Illinois; discrimination is not intended against any product. The reader is urged to exercise caution in making purchases or evaluating product information.

Label registrations can change at any time. Thus the recommendations in this chapter may become invalid. The user must read carefully the entire, most recent label and follow all directions and restrictions. Purchase only enough pesticide for the current growing season.

although the mobility of some herbicides may be reduced by lightly incorporating them into the soil surface.

The half-life of the compound in the soil, the surface water, and the air can affect the hazard potential. Variability of this factor is also great and is dependent on environmental conditions of light, temperature, and moisture. For a more complete treatment of this topic, see Chapter 20, "Factors Affecting Herbicide Persistence."

For the trade names corresponding to the active ingredients listed, see Chapter 17, "Herbicide Formulations and Toxicities." Data in the following table have been extracted from the *Herbicide Handbook* (7th ed., 1994), published by the Weed Science Society of America, and from "Extoxnet," a compilation of data by the Extension offices of Oregon State University, Cornell University, the University of California, and Michigan State University.

Table 1. Toxicity and half-life of various herbicides

	Toxicity			Rate of breakdown or half-life (days) of parent compound			
Herbicide	Bluegill (LC_{50}, ppm)	Rainbow trout (LC_{50}, ppm)	Mallard duck (LC_{50})[a]	Soil	Air	Water	Breakdown methods[b]
2,4-D[c]	>110	64	>1,000 mg/kg	46	Fast	Very fast	P-M
2,4-DB	4	4	>1,000	—	—	—	P-M
Acetochlor	1.3	0.45	>5,620	55	Slow	Slow	M
Acifluorfen	62	17	5,620 mg/kg	14–59	4	2	P-H[2]
Alachlor	6.4	4.2	5,000	21	Slow	—	P-H[2]
Ametryn	4.1	8.8	23,000	60	Slow	—	M
Atrazine	>24	4.5	19,650	60	Slow	—	M-H[2]
Benefin	—	—	5,000 mg/kg	40	Moderate	—	P-M[2]
Bensulide	1.4	0.72	—	120	Slow	—	P-M[2]
Bentazon	616	190	>5,000 mg/kg	14	Very slow	<24 hr	M-P[2]
Bromacil	71	75	>10,000	150	Very slow	—	M
Bromoxynil	0.10	0.17	200 mg/kg	7	—	—	—
Butylate	6.9	7.2	>40,000[d]	10–20	—	—	M
Cacodylic acid	133	152	>5,620	50	Very slow	—	—
Carfentrazone	2	1.6	>5,620	1	—	8	M
Chlorimuron	>100	>1,000	>2,510	21–42	Slow	—	H-M[2]
Chlorsulfuron	>250	>250	>5,000	28–42	Slow	30	H-M[2]
Clethodim	>100	67	>3,978	2	2	28	M-H-P[2]
Clomazone	34	19	>5,620	28–84	Very slow	—	M-P[2]
Clopyralid	125	103	>4,640	12–70	Very slow	—	M
Cloransulam	>295	>252	>5,620	13–28	Slow	—	M
Copper chelate	1.2	0.2	>1,000	N/A	na	—	None
Cyanazine	23	9	>2,000	12–25	Slow	Slow	M-H[2]
Cycloate	—	5.6	>56,000[d]	28–42	Very slow	219	M
Dicamba	>1,000	>1,000	>4,600	14–42	Slow	Slow	M-P[2]
Dichlobenil	7	7	>5,200	60–180	Very slow	10	M-P[2]
Dichlorprop	1.1	100–200	—	10	—	—	—
Diclofop	—	1.38	>20,000	10–30	Fast	—	H-M[2]
*Diflufenzopyr	135	106	>5,620	30	Slow	Slow	—
Dimethenamid	6.4	2.6	>5,620	18	—	5	M-P[2]
Dithiopyr	0.5	0.5	>5,620	—	—	—	—

Table 1. Toxicity and half-life of various herbicides (cont.)

Herbicide	Toxicity: Bluegill (LC_{50}, ppm)	Toxicity: Rainbow trout (LC_{50}, ppm)	Toxicity: Mallard duck (LC_{50})[a]	Rate of breakdown or half-life (days) of parent compound: Soil	Air	Water	Breakdown methods[b]
Diquat	—	21	564 mg/kg	na	Fast	<2	—
Diuron	7.4	4.3	>5,000	90	Moderate	Slow	M-P[2]
Endothall	—	—	—	7	Very slow	—	M
EPTC	27	21	20,000[d]	7–14	—	—	
Ethalfluralin	0.03	0.04	>5,000 mg/kg	42–56	Moderate	—	M-P
Fenoxaprop	3.3	3.4	Not toxic	5–14	Slow	—	—
Fluazifop	0.5	1.4	>3,528 mg/kg	28–56	Very slow	—	—
Flufenacet	2.13	3.5	>4,970	29-62	Very slow	Very slow	H
Flumetsulam	>300	>293	>5,620	90	Slow	Very slow	M
Flumiclorac	48	30	2,974	85	1	3	H-P
Fluridone	14.3	11.7	>5,000 mg/kg	Moderate	—	21–42	M-P
Fluthiacet	0.14	0.043	>2,250	1	—	—	M-P
Fomesafen	6,030	680	>5,000 mg/kg	120–240	Fast	Fast	M-P
Fosamine	670	1,000	>10,000 mg/kg	10	Very slow	Very slow	M
Glufosinate	—	>320	>2,000 mg/kg	7	—	—	M
Glyphosate							
Rodeo	1,000	>1,000	>4,640	3	Very slow	—	M
Roundup	6–14	8–26	>4,640	3	Very slow	—	M
Touchdown	1.6	1.2	950	—	—	—	—
Halosulfuron	Low	Low	>5,620	25–30	Very slow	3–5	M
Hexazinone	>370	>320	>10,000	60–120	Moderate	Moderate	M-P[2]
Imazamox	119	122	5,572	30	Moderate	Slow	M
Imazapyr	>100	>100	>5,000 mg/kg	90–180	Moderate	2	M-P[2]
Imazaquin	>100	>100	>5,000 mg/kg	90–180	2	1	M-P
Imazethapyr	420	340	>5,000	60–180	1	1	M-P
Isoxaflutole	—	—	—	35	—	—	—
Lactofen	0.5	0.8	>5,620	14–21	23	23	M
Linuron	16	16	3,083	60–120	Very slow	Moderate	M-P[2]
MCPA	>10	117	—	10–180	Very slow	—	—
Mecoprop	—	—	—	7–21	Very slow	—	—
Metolachlor	10	4	>10,000	25–50	8	Very slow	M-P[2]
Metribuzin	>100	>100	>4,000 mg/kg	30–60	Very slow	Very slow	M
Metsulfuron	>150	>150	>2,510	30	Slow	—	H-M[2]
Napropamide	30	17	—	56–100	4	—	P-M
Naptalam	354	76	>10,000	21–42	Very slow	—	—
Nicosulfuron	>1,000	>1,000	>5,620	21	—	—	—
Norflurazon	16	8	>10,000	48–180	Moderate	Fast	P
Oryzalin	2.9	3.6	>5,000 mg/kg	20–180	Moderate	—	M-P
Oxadiazon	—	>9	>1,000	60	—	—	—

Table 1. Toxicity and half-life of various herbicides (cont.)

Herbicide	Toxicity: Bluegill (LC_{50}, ppm)	Toxicity: Rainbow trout (LC_{50}, ppm)	Toxicity: Mallard duck (LC_{50})[a]	Rate of breakdown or half-life (days of parent compound): Soil	Air	Water	Breakdown methods[b]
Oxyfluorfen	0.2	0.4	>5,000 mg/kg	30–40	Fast	Fast	M-P
Paraquat	Very toxic	Very toxic	Very toxic	nd[e]	Moderate	Moderate	P
Pebulate	7.4	7.4	>2,000	14	—	—	M
Pendimethalin	1.0	0.5	10,388	30–60	Moderate	Moderate	P-M
Picloram	14	4	>5,000 mg/kg	70–100	3	3	P-M
Primisulfuron	>180	210	>2,160	13	Moderate	Moderate	P-M
Prodiamine	>0.5	>0.8	>10,000	120	2	—	M-P
Prometon	>32	20	>4,572	100–200	Moderate	—	M
Prometryn	10	2.5	39,000	30–90	Moderate	Slow	M-P[2]
Pronamide	100	72	>20,000	60–270	Slow	—	M-P[2]-H[2]
Propachlor	1.6	0.42	>5,000	30–42	Very slow	—	M
Prosulfuron	155	160	>5,000	10	118	—	M-H[2]
Pyridate	2	14	>5,000	7–21	Slow	Slow	H-M[2]
Quizalofop	0.5–3.0	10	>2,000 mg/kg	7–21	Moderate	—	M
Rimsulfuron	>1,000	>1,000	>2,250	—	—	—	—
Sethoxydim	100	32	>2,510	4–10	Moderate	Fast	M-P
Simazine	2.8	16	51,000	30–90	Moderate	—	M
Sodium borate	Low	Low	Low	>365	Very slow	—	—
Sodium chlorate	Very toxic	Very toxic	—	—	—	—	—
Sulfentrazone	94	>130	>5,220	110–280	Slow	—	M
Sulfometuron	>12.5	>12.5	>5,000	20–28	—	—	H-M[2]
Tebuthiuron	112	144	>2,000 mg/kg	360–500	Slow	—	M
Terbacil	86[f]	—	>56,000	180	—	—	M-P[2]
Thifensulfuron	>100	>100	>5,600	7–21	—	—	M-H[2]
Triallate	1.3	1.2	>5,000	48–56	Very slow	—	M
Tribenuron	>1,000	>1,000	>5,620	10	Slow	Moderate	H
Triclopyr							
Garlon 3A	891	552	>10,000	46	Fast	Very fast	P-M
Garlon 4L	0.9	0.7	>10,000	—	—	—	P-M
Trifluralin	Toxic	Toxic	>5,000 mg/kg	60–90	Moderate	—	M-P

Table 1. Toxicity and half-life of various herbicides (cont.)

Herbicide	Toxicity: Bluegill (LC_{50}, ppm)	Toxicity: Rainbow trout (LC_{50}, ppm)	Toxicity: Mallard duck (LC_{50})[a]	Rate of breakdown or half-life (days of parent compound): Soil	Air	Water	Breakdown methods[b]
Safeners in certain herbicide formulations							
Benzacor	6	3	3,600	60		—	P-M
Concept II	12	7.1	>2,000	—		—	—
Dichlormid	—	—	—	7–8		—	M
Dietholate	—	—	—	14–28		—	—
R-29148	—	—	—	—		—	—

— = no information available; nd = not determined; na = not applicable.
[a]Reported as ppm unless otherwise noted.
[b]H = hydrolysis, M = microbial, P = photolysis. A superscript numeral (^{2}) indicates that the method is not a principal route of breakdown.
[c]Some formulations are particularly toxic to fish.
[d]Quail were used as test animals.
[e]Bound too tightly to soil for determination.
[f]Pumpkinseed sunfish were used as test animals.
*Toxicity defined by commercial product (Distinct).

Recommended Web Resources

http://ext.agn.uiuc.edu/piap/
Pest impacts and pesticide benefits. Includes links to national programs.

http://ext.agn.uiuc.edu/extension/
University of Illinois Extension programs for pest management.

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