

## TOXICITY OF HERBICIDES

Toxicity is the capacity of a substance to produce injury. Toxic effects may be immediate (acute) or accumulative (chronic), depending upon the exposure duration, the dose, and the herbicide. The toxicity of a substance varies with the animal species, age, sex, and nutritional status and with the route of exposure—through the stomach (orally), the lungs (by inhalation), or the skin (dermally). The skin and eyes are also subject to irritation caused by chemicals.

### HUMAN TOXICITY OF HERBICIDES

Pesticide manufacturers are required to conduct acute, subacute, and chronic toxicity tests, including tests for mutagenicity, teratogenicity, and carcinogenicity. The usual expression of acute toxicity is  $LD_{50}$ , which is the average lethal dose in milligrams per body weight in kilograms (mg/kg) required to kill 50 percent of a test population. Toxicity tests are conducted on experimental animals, such as white rats, mice, and rabbits.

To make mg/kg more meaningful, the following factors are given to convert mg/kg to ounces per pound (oz/lb) for a 100-pound person and a 187-pound person:

$$\text{mg/kg} \times 0.0016 = \text{oz}/100 \text{ lb}$$

$$\text{mg/kg} \times 0.0030 = \text{oz}/187 \text{ lb}$$

Because toxicity depends upon body weight, the amount of chemical considered lethal for a child is less than the amount for an adult. And conversely, it takes more to kill a large animal than a small one.

The classes of toxicity are given in Table 1. The herbicide label indicates the extent of toxicity by the sig-

nal word(s) it carries. The signal word on the label applies to the most serious method or route of exposure. For example, if a herbicide has an acute oral  $LD_{50}$  of 368 (which triggers the signal word “Warning”) and an acute dermal  $LD_{50}$  of  $>2,000$  (which triggers “Caution”) and is severely and irreversibly corrosive to the eyes (which warrants “Danger”), then the label signal word is “Danger.”

### DANGER-POISON

Herbicides with the active ingredient endothall or paraquat carry the signal word “Danger” plus a skull and crossbones. Endothall is available in liquid form as Endothall Turf (1.25), Aquathol K (3S), and Hydrothol 191 (2S). Paraquat is available as Zeneca’s Gramoxone Extra and Cyclone.

These herbicide labels carry the following precautions: The user is advised to wear goggles or a face shield, rubber gloves, and a rubber apron when working with concentrates and to avoid breathing spray mists.

### DANGER-CORROSIVE

The signal words “Danger-Corrosive” indicate the risk of irreversible eye or skin burns. This warning is usually accompanied by a recommendation that the user wear goggles or a face shield, especially when handling concentrates. The label also may call for wearing rubber gloves and an apron when handling or mixing concentrates or adjusting equipment. The first-aid statement states, “In case of contact with eyes, immediately flush eyes with plenty of water for at least 15 minutes and **get medical attention promptly.**” If the contact is with the skin, the label

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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.*

**Table 1. Toxicity classes of herbicides**

Toxicity class	Label signal words	Acute oral LD <sub>50</sub> (mg/kg)	Acute dermal LD <sub>50</sub> (mg/kg)	Acute inhalation LC <sub>50</sub> * (mg)
High	Danger–Poison	<50	<200	<0.2
Moderate	Warning	50–500	200–2,000	0.2–2
Low	Caution	500–5,000	2,000–20,000	2–20
Very low	Caution	>5,000	>20,000	>20

\*LC<sub>50</sub> = concentration of pesticide, in milligrams per liter of air space, required to kill 50 percent of a test population.

calls for washing with plenty of water. If skin irritation occurs, medical attention should be sought. Herbicides in this category are listed in Table 2.

#### WARNING

“Warning” is the signal word used for herbicides containing an active ingredient that is moderately toxic through oral, dermal, or inhalation exposure. The labels state, under “Human Precautions,” “May be fatal or harmful if swallowed, inhaled, or absorbed through the skin.” The following herbicides contain such a warning:

#### BROMOXYNIL

Buctril 2EC, Buctril + atrazine, Moxy, Moxy + atrazine

#### CYANAZINE

Bladex 4L, 90DF; CyPro 90DF, 4L; Extrazine II 4L, 90DF

#### DIQUAT

Reward, Weedtrine-D

“Warning” also appears as a signal word for herbicides with label statements indicating that they can cause eye or skin irritation or burns or may be harmful if swallowed, inhaled, or absorbed through the skin. Herbicides in this category are listed in Table 3.

Most of these herbicide labels state, “Do not get into eyes or on skin.” If skin or eye contact occurs, the labels advise washing the contacted areas thoroughly for 15 minutes and calling a physician in case of eye contact. Some herbicide labels recommend wearing goggles or a face shield and other protective clothing. Fusilade, Goal, and Laddok labels specify the use of goggles or a face shield. Dual, Fusilade, and Laddok labels also call for the use of rubber gloves.

**Table 2. Herbicides labeled with the signal words “Danger–Corrosive”**

Trade name	Common name
Accent Gold	nicosulfuron + rimsulfuron + flumetsulam + clopyralid
Aquathol 7G, 3S	endothall
Assure II	quizalofop
Blazer/Status 2S	acifluorfen
Broadstrike + Treflan 3.65EC	flumetsulam + trifluralin
Butoxone 200 2S	2,4-DB amine
Butyrac 200 2S	2,4-DB amine
Cobra 2S	lactofen
Detail 4.1EC	imazaquin + dimethenamid
Devrinol 2EC	napropamide
Galaxy 3.67S	acifluorfen + bentazon
Garlon 3A	triclopyr amine
Gramoxone Extra 2.5S	paraquat
Hornet 85.6SP	flumetsulam + clopyralid
Hydrothol 191 2S	endothall
Laddok S-12 5L	bentazon + atrazine
Lasso 4EC	alachlor
Many	2,4-D amine
Optill 6E	dicamba + dimethenamid
Pramitol 25E, 5PS	prometon
Ramrod 4FL, 20G	propachlor
Reflex 2L	fomesafen
Scepter O.T. 2.5EC	imazaquin + acifluorfen
Scorpion III 84WG	flumetsulam + clopyralid + 2,4-D
Shotgun 3.25L	atrazine + 2,4-D
Sonalan HFP 3EC	ethalfluralin
Squadron 2.33EC	imazaquin + pendimethalin
Steel 2.6EC	imazethapyr + imazaquin + pendimethalin
Stellar 3.1EC	flumicorac + lactofen
Storm 4S	acifluorfen + bentazon
Velpar 90SP, 75DF, 2L	hexazinone
Weedone 638 2.8EC	2,4-D acid + ester

**Table 3. Herbicides labeled with the signal word “Warning”**

Trade name	Common name
Acclaim 1EC	fenoxaprop
Acme Super Brush 4.5EC	2,4-D + dicamba + dichlorprop
Alanap L 2S	naptalam
Banvel 4S	dicamba
Bladex 4L, 90DF	cyanazine
Broadstrike + Dual 7.67EC	flumetsulam + metolachlor
Buctril 2EC	bromoxynil
CyPro 4L, 90DF	cyanazine
DoublePlay 7EC	acetochlor + EPTC
Extrazine II 4L, 90DF	cyanazine + atrazine
Flexstar 1.88S	fomesafen
Frontier 6EC	dimethenamid
Goal 2XL	oxyfluorfen
Harness 7EC	acetochlor + safener
Hyvar X-L 2S	bromacil
Karmex 80DF	diuron
Lasso II 15G	alachlor
Liberty 1.67S	glufosinate
Lightning 90WG	imazethapyr + imazapyr
Moxy 2EC	bromoxynil
Poast/Prestige 1.5EC	sethoxydim
Pursuit 70DG	imazethapyr
Resource 0.86EC	flumiclorac
Reward 2S	diquat
Ronstar 2.5G, 50WP	oxadiazon
Select 2EC	clethodim
Steel	pendimethalin + imazethapyr + imazaquin
Surpass 6.4EC	acetochlor
Tough 3.75S	pyridate
Treflan HFP 4EC	trifluralin
Tri-4 HF 4EC	trifluralin
Tri-Scept 3EC	trifluralin + imazaquin

Any herbicide that does not have a “Danger” or “Warning” signal word has “Caution” on the label. “Caution” indicates that the product has low oral, dermal, and inhalation toxicity and has little or no irritability to either the eyes or the skin.

## ENVIRONMENTAL TOXICITY OF HERBICIDES

The “Environmental Hazards” section of the label includes statements regarding toxicity to fish and wildlife, and the user is urged to be especially careful in this regard. Herbicides that state they are toxic to fish or wildlife contain the active ingredients bromoxynil, propachlor, or others:

### BROMOXYNIL

Buctril 2EC  
Buctril + atrazine 3WDL  
Moxy 2EC  
Moxy + atrazine 3WDL

### PROPACHLOR

Ramrod 4L, Ramrod + atrazine 4L

### OTHERS

Goal (oxyfluorfen)  
Gramoxone Extra (paraquat)  
Reward, Weedtrine-D (diquat)

Some herbicide labels carry the statement “Toxic to Fish.” These include certain esters of phenoxy and pyridinoxy-phenoxy herbicides, the dinitroaniline herbicides, and miscellaneous others. All herbicide labels warn the user to keep the product out of lakes and streams.

### DINITROANILINES (DNAs)

Balan (benefin)  
Prowl, Pentagon (pendimethalin)  
Sonalan, Curbit (ethalfuralin)  
Treflan, Tri-4 (trifluralin)

### DNA MIXES

Broadstrike + Treflan (flumetsulam + trifluralin)  
Pursuit Plus (pendimethalin + imazethapyr)  
Squadron (pendimethalin + imazaquin)  
Steel (pendimethalin + imazethapyr + imazaquin)  
Tri-Scept (trifluralin + imazaquin)

### OXY-PHENOXY ESTERS

Fusilade DX 2EC (fluazifop)  
Fusion 2.56EC (fluazifop + fenoxaprop)  
Horizon 2000 2.56EC (fenoxaprop + fluazifop)

### PHENOXY ESTERS

(There are many phenoxy herbicide products.)  
Crossbow 3EC  
Esteron 3.8EC, 99  
Weedone 170, Brushout 3.7E  
Weedone LV4EC, LV6EC

**Table 4. Herbicides carrying label statements about groundwater contamination**

Trade name	Common name	Trade name	Common name
AAtrex, Atrazine	atrazine	Guardsman/LeadOff	dimethenamid + atrazine
Accent Gold	rimsulfuron + nicosulfuron + flumetsulam + clopyralid	Harness	acetochlor
Access	picloram + triclopyr	Harness Xtra	acetochlor + atrazine
Authority	sulfentrazone	Hornet	flumetsulam + clopyralid
Balance	isoxaflutole	Hyvar X, XL	bromacil
Basagran	bentazon	Krovar	bromacil + diuron
Basis Gold	rimsulfuron + nicosulfuron + atrazine	Laddok S-12	atrazine + bentazon
Bicep, Bicep Magnum	metolachlor + atrazine	Lasso	alachlor
Bladex, CyPro	cyanazine	Liberty ATZ	glufosinate + atrazine
Blazer, Status	acifluorfen	Lightning	imazethapyr + imazapyr
Broadstrike + Dual	flumetsulam + metolachlor	Marksman	dicamba + atrazine
Broadstrike + Treflan	flumetsulam + trifluralin	Micro-Tech	alachlor
Buctril + atrazine	bromoxynil + atrazine	Northstar	primisulfuron + dicamba
Bullet	atrazine + alachlor	Optill	dimethenamid + dicamba
Canopy	metribuzin + chlorimuron	Pathway	picloram + 2,4-D
Canopy XL	sulfentrazone + chlorimuron	Python	flumetsulam
Detail	imazethapyr + dimethenamid	Princep	simazine
DoublePlay	acetochlor + EPTC	Ramrod	propachlor
Dual, Dual Magnum	metolachlor	Scorpion III	flumetsulam + clopyralid + 2,4-D
Epic	isoxaflutole + flufenacet	Sencor	metribuzin
Exceed, Spirit	primisulfuron + prosulfuron	Shotgun	atrazine + 2,4-D
Extrazine II	cyanazine + atrazine	Sim-Trol	simazine
Field Master	acetochlor + atrazine + glyphosate	Stinger	clopyralid
FirstRate	chloransulam	Surpass	acetochlor
Frontier	dimethenamid	TopNotch	acetochlor
FulTime	acetochlor + atrazine	Tordon 101	picloram + 2,4-D
Galaxy/Storm	acifluorfen + bentazon	Tordon K	picloram
		Tordon RTU	picloram + 2,4-D
		Turbo	metribuzin + metolachlor

The potential for contaminating groundwater with pesticides has prompted the addition of groundwater statements on several pesticide labels, especially products containing atrazine, simazine, cyanazine, dimethenamid, alachlor, metolachlor, or metribuzin. Table 4 lists herbicides carrying label statements cautioning the user to handle the herbicides in a manner that minimizes the potential for groundwater contamination.

## **AUTHORS**

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