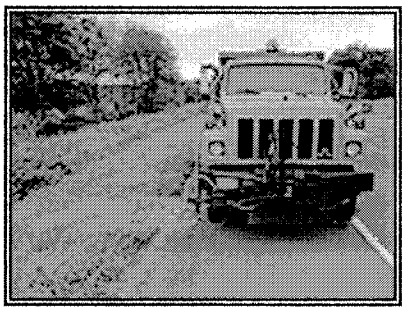
Washington State
Department of Transportation



Glyphosate

Roadside Vegetation Management Herbicide Fact Sheet

This fact sheet was developed by Oregon State University and Intertox, Inc. to assist interested parties in understanding the risks associated with pesticide use in Washington State Department of Transportation's (WSDOT) Integrated Vegetation Management program.

Introduction

Glyphosate is a broad-spectrum herbicide used to control a wide variety of weeds, brush, and plants. It interferes with cellular processes important for normal plant functioning. Only plants and microorganisms have these specific cellular processes. Glyphosate is the active ingredient in the herbicide products **Roundup** (41%), **Rodeo** (53.8%), and **Aquamaster** (53.5%) used by the Washington State Department of Transportation (WSDOT) for non-selective control of foliage most commonly in the maintenance of vegetation free gravel shoulders. Glyphosate also has agricultural, home and garden, and forestry uses.

WSDOT assessed the potential risks to humans, wildlife, and aquatic animals exposed to glyphosate in their Integrated Vegetation Management (IVM) program. Evaluating potential risks takes into account both the toxicity of a pesticide and the characteristics of possible exposure.

Laboratory Testing: Before pesticides are registered by the U.S. Environmental Protection Agency (EPA), they must undergo laboratory testing for short-term (acute) and long-term (chronic) health effects. Laboratory animals are purposely fed doses high enough to cause toxic effects. These tests help scientists determine how chemicals might affect humans, domestic animals, or wildlife in cases of overexposure. Pesticide products used according to label directions are unlikely to cause toxic effects. The amount of pesticide that people and pets may be exposed to is low compared to the doses fed to laboratory animals.

Application Rates and Use Patterns on Highway Rights-of-Way

Typical rights-of-way application rates range from 32 to 64 ounces of product per acre, or a maximum of about 2 pounds of glyphosate per acre. Applicators use truck-mounted side booms or backpack sprayers to apply Roundup, Rodeo, and Aquamaster throughout the year. WSDOT workers applied 7,117 pounds of glyphosate statewide during 2002.

Human Health Effects

The U.S. Environmental Protection Agency (EPA) classifies Roundup as toxicity class II (moderate toxicity), and Rodeo and Aquamaster as toxicity class III (slight toxicity). Roundup has a signal word of WARNING because it causes substantial but temporary eye injury and is harmful if swallowed or inhaled. Rodeo and Aquamaster have a signal word of CAUTION because they are harmful if inhaled. (See Toxicity Category and Signal Word table).

Acute toxicity: Glyphosate has low toxicity if individuals accidentally eat or inhale residues and very low toxicity if touched. It is not a skin irritant or sensitizer but it is an eye irritant. Severe eye damage from exposure to Roundup is rare. Roundup has caused irritation of the mouth, nausea, intestinal discomfort, vomiting and diarrhea when eaten by people. Eating large amounts has caused hypotension (low blood pressure) and pulmonary edema (fluid in the lungs).

Chronic toxicity: In one study, Glyphosate caused no adverse effects when fed to rats in moderate doses for 2 years. In a second long-term feeding study, glyphosate caused changes in urine, increases in liver weights, decreases in body weight gain, and increases in the number of cataracts (damaged eye lens) and lens changes. Glyphosate caused cellular changes in the liver and kidneys of mice fed high doses for 2 years, and decreases in the pituitary weights of dogs fed high doses for 1 year.

Toxicity Category and Signal Word

	High Toxicity (*Danger*)	Moderate Toxicity (*Warning*)	Low Toxicity (*Caution*)	Very Low Toxicity (*Caution*)
Oral LD50	Less than 50 mg/kg	50-500 mg/kg	500-5000 mg/kg [1]	Greater than 5000 mg/kg
Dermal LD50	Less than 200 mg/kg	200-2000 mg/kg	2000-5000 mg/kg	Greater than 5000 mg/kg
Inhalation LC50	Less than 0.05 mg/l	0.05-0.5 mg/l	0.5-2.0 mg/l [2]	Greater than 2.0 mg/l
Eye Effects	Corrosive	Irritation persisting for 7 days	Irritation reversible in 7 days	Minimal effects, gone in 24 hrs
Skin Effects	Corrosive	Severe irritation at 72 hours	Moderate irritation at 72 hours	Mild or slight irritation

[1]Highlighted categories specify the range for glyphosate use cited in this fact sheet.
[2]Low Toxicity inhalation classification is limited to the formulated products Rodeo and Aquamaster.

Reproductive effects: Studies have shown that glyphosate does not affect reproduction when fed to rats at moderate to high doses over two or three generations. However, it did cause decreases in offspring body weights, increases in the number of miscarriages, and bone formation problems when fed to rats during 14 critical days of pregnancy. In humans, miscarriages are not associated with male farm activities involving glyphosate; there may be an increased risk of pre-term delivery. Glyphosate caused kidney changes in the third generation pups of rats exposed through their food. It caused no birth defects in rabbits when given during pregnancy.

Carcinogenic effects: Rats fed moderate doses of glyphosate for 2 years had no increase in the number of tumors. Mice, fed moderate doses for 2 years, developed an increase in the number of kidney tumors. The EPA lists glyphosate as a Group D human carcinogen (unclassifiable due to insufficient or conflicting data). Multiple studies show that glyphosate is not a mutagen.

LD50/LC50: Acute toxicity is commonly measured by the lethal dose (LD) or lethal concentration (LC) that causes death in 50 percent of treated laboratory animals. LD50 indicates the dose of a chemical per unit body weight of an animal and is expressed as milligrams per kilogram (mg/kg). LC50 is the concentration of a chemical per volume of air or water and is expressed as milligrams per liter (mg/L). Chemicals are highly toxic when the LD50 or LC50 value is small and practically nontoxic when the value is large. However, the LD50 and LC50 do not reflect potential health effects such as cancer, birth defects, or reproductive toxicity that may occur at levels of exposure below those that cause death.

Fate in humans and animals: Rats fed glyphosate eliminated over 97% of the pesticide in their urine and feces. Less than 1% remained in the body, primarily in bone tissue. Further studies revealed that the body rapidly eliminates glyphosate residues in bone tissues.

Wildlife Effects

Effects on Mammals: Glyphosate is practically non-toxic to mammals. The LD50 for rats fed glyphosate is 5,600 milligrams per kilogram (mg/kg) and for rabbits 3,800 mg/kg. The LD50 for rabbits exposed by skin contact is greater than 5,010 mg/kg. (See LD50/LC50 text box and Wildlife Toxicity Category table).

Wildlife Toxicity Category

Risk Category	Mammals	Birds	Fish or Aquatic Insects
	Acute Oral or Dermal LD_{50} (mg/kg)	Acute Oral LD_{50} (mg/kg)	Acute LC_{50} (mg/L)
Practically nontoxic	>2,000	>2,000	>100
Slightly toxic	501-2,000	501-2,000	>10-100
Moderately toxic	51-500	51-500	>1-10
Highly toxic	10-50	10-50	0.1-1
Very highly toxic	<10	<10	<0.1

Highlighted categories specify the range for glyphosate use cited in this fact sheet.

Effects on birds: Glyphosate is practically non-toxic to birds. The acute LD50 is greater than 2,000 mg/kg for the mallard and greater than 4,640 mg/kg for the northern bobwhite. The LC50 for glyphosate given through the

food is 4,640 mg/kg, indicating it is slightly toxic for mallard ducks and bobwhite quail.

Effects on fish: Glyphosate is practically non-toxic to moderately toxic to fish. It does not bioaccumulate (build up) in the bodies of fish.

Effects on aquatic invertebrates: Glyphosate is slightly toxic to practically nontoxic to aquatic insects. It does not bioaccumulate (build up) in these organisms.

Half-life is the time required for half of the compound to degrade.

1 half-life = 50% degraded
2 half-lives = 75% degraded
3 half-lives = 88% degraded
4 half-lives = 94% degraded
5 half-lives = 97% degraded

Remember: the amount of a chemical remaining after a half-life will always depend on the amount of the chemical originally applied.

Environmental Fate

The half-life of glyphosate in soils ranges from 1 to 174 days with a typical time of 47 days. (See half-life text box). Microbes breakdown glyphosate in the environment. Glyphosate is not mobile and has a very low potential to contaminate groundwater. It can move throughout plant tissues, including the roots.

Human Health Risk Assessment

WSDOT evaluated several human exposure scenarios, including adults and children eating drift-contaminated garden vegetables or children directly touching drift-contaminated berries or sprayed vegetation. For each exposure scenario, WSDOT evaluated conditions of average exposure and extremely conservative conditions of maximum exposure. (See Human Cancer/Non-cancer text box and Human Risk Classification under Conditions of Average Exposure table). Glyphosate poses a negligible risk of adverse non-cancer effects to WSDOT workers and the public under conditions of average exposure. All hazard quotients are below 1. Glyphosate may pose a low potential risk of adverse non-cancer effects to the public under two of the maximum case exposure scenarios. These are adults and children ingesting drift-contaminated garden vegetables, with hazard quotients of 3.9 and 5.0, respectively. Hazard quotients for all other maximum case public exposure scenarios are below 1. WSDOT workers are at potential low risk of adverse non-cancer effects from applying glyphosate under maximum case exposure assumptions. Hazard quotients for workers engaged in broadcast spray applications and directed foliar applicators are 4.8 and 1.1, respectively.

Human Cancer/Non-cancer Risk Classification: Scientists estimate non-cancer health risks by generating a hazard quotient (HQ). This number is the exposure divided by the toxicity. When the HQ is less than 1, exposures are unlikely to cause any adverse health effects. When the HQ is greater than 1, potential non-cancer health effects may be possible. Risk assessments for chemicals that cause cancer (carcinogens) estimate the probability of an individual developing cancer over a lifetime. Cancer risks estimated in this way are very conservative, and actual cancer risks are likely to be much lower. Cancer risk estimates of less than 1 in 100,000 are within the range considered negligible by most regulatory agencies.

Human Risk Classifications under Conditions of Average Exposure

Hazard Quotient (Non-cancer Risk)	Cancer Risk	Potential Risks and Management Priority
Less than 1	Less than 1 in 100,000	**Negligible**
Between 1 and 10	Between 1 in 10,000 and 1 in 100,000	**Low**
Between 10 and 100	Between 4 in 1,000 and 1 in 10,000	**Moderate**
Greater than 100	Greater than 4 in 1,000	**High**

Note: Highlighted categories specify the range of potential risk for specific exposure scenarios involving glyphosate.

Wildlife Risk Assessment

Wildlife risk assessment considers pesticide behavior in the environment and routes of exposure. Indirect exposure to mammals and birds can occur when they eat contaminated prey or vegetation. Direct exposure can occur when mammals and birds contact pesticide residues with their skin or eyes or when they inhale vapors or particulates. WSDOT's current application rates and use patterns for glyphosate pose a negligible to low risk to mammals. The estimated dietary doses for rats, deer mice, and meadow voles are approximately 230 to 2,000 times lower than the rat LD50 of 5,600 mg/kg. The estimated exposure poses a negligible risk to rats and a low risk to deer mice and meadow voles. The risk to birds is low. The estimated dietary doses for bobwhite quail, marsh wrens, and American robins are approximately 90 to 120 times lower than the quail LD50 of >5,000 mg/kg.

Aquatic Risk Assessment

WSDOT takes extra precautions applying herbicides near open water, wetlands, or wellhead protection zones. However, contamination may result from application drift, rainfall runoff, or residue leaching through the soil into groundwater. Fish and aquatic insect exposure to glyphosate occurs primarily through direct contact with contaminated surface waters. Glyphosate does not bioaccumulate (build up) in aquatic animals. WSDOT's current use of glyphosate poses a low risk to fish and aquatic insects in all areas of the state. (See Wildlife Toxicity Category table).

Additional Resources

- National Pesticide Information Center 1-800-858-PEST (7378) and http://npic.orst.edu
- Extension Toxicology Network (EXTOXNET) http://extoxnet.orst.edu
- Washington State Department of Transportation, Roadside Maintenance Branch 1-360-705-7865
- Washington Department of Agriculture, Pesticide Management Division 1-877-301-4555 (toll free)