

Glyphosate

HERBICIDE FACT SHEET

U.S. DEPARTMENT OF ENERGY
BONNEVILLE POWER ADMINISTRATION

This fact sheet is one of a series issued by the Bonneville Power Administration for their workers and the general public. It provides information on forest and land management uses, environmental and human health effects, and safety precautions. A list of definitions is included in Section VIII of this fact sheet.

I. BASIC INFORMATION

COMMON NAME: glyphosate

CHEMICAL NAME: N-(phosphonomethyl)glycine

Cas No. 38641-94-0

CHEMICAL TYPE: phosphanoglycine

PESTICIDE CLASSIFICATION: herbicide

REGISTERED USE STATUS: "General Use."

FORMULATIONS: Commercial herbicide products generally contain one or more ingredients. An inert ingredient is anything added to the product other than an active ingredient. Because of concern for human health and the environment, EPA announced its policy on toxic inert ingredients in the Federal Register on April 22, 1987 (52FR13305). This policy focuses on the regulation of inert ingredients. EPA's strategy for implementing this policy included the development of four lists of inerts, based on toxicological concerns. Inerts of toxicological concern were placed on List 1. Potentially toxic inerts/high priority for testing were placed on List 2. Inerts of unknown toxicity were placed on List 3, and inerts of minimal concern were placed on List 4.

The inert ingredients of the glyphosate formulations are not classified by the USEPA as inert ingredients of toxicological concerns to humans or the environment.

There are many formulations of glyphosate, including:

Accord [®] Herbicide (Terrestrial/Aquatic Uses) Glyphosate 41.5 % Inert 58.5 %	Accord [®] Site Prep (Terrestrial Uses) Glyphosate 41 % Inert 59 %
Glypro [®] Specialty Herbicide (Terrestrial/Aquatic Uses) Glyphosate 53.8 % Inert 46.2 %	Glypro [®] Plus (Terrestrial Uses) Glyphosate 41 % Inert 59 %
Glyphomax [®] Herbicide (Terrestrial Uses) Glyphosate 41 % Inert 59 %	Glyphos [®] Herbicide (Terrestrial Uses) Glyphosate 41 % Inert 59 % (Ethoxylated Tallowamines)
Glypro [®] Plus (Terrestrial Uses) Glyphosate 41 % Inert 59 %	Honcho [®] Herbicide (Terrestrial Uses) Glyphosate 41 % Inert 59 % (Ethoxylated Tallowamines)
Rodeo [®] Emerged Aquatic Weed and Brush Herbicide (Terrestrial/Aquatic Uses) Glyphosate 53.8 % Inert 46.2 %	Roundup Ultra [®] Herbicide (Terrestrial Uses) Glyphosate 41 % Inert 59 %

RESIDUE ANALYTICAL METHODS: EPA Method 547.

II. HERBICIDE USES

REGISTERED FORESTRY, RANGELAND AND RIGHT-OF-WAY USES: Glyphosate is registered for use in crop and non-crop sites, including aquatic sites, for post-emergent weed and woody plant control. For terrestrial and aquatic use.

OPERATIONAL DETAILS:

TARGET PLANTS: Broad spectrum, non-selective for grasses, weeds and woody plants.

MODE OF ACTION: Glyphosate is absorbed by the leaves preventing the plant from producing an essential amino acid.

METHOD OF APPLICATION AND RATES: Aerial and ground broadcast, spot and localized applications. Application rates vary.

SPECIAL PRECAUTIONS:

TIMING OF APPLICATION: Timing is dependent on the target plant. As glyphosate must be absorbed through the leaves, timing is limited to emerged plants.

DRIFT CONTROL: Care should be exercised not to overspray or apply the herbicide to adjacent non-target areas. Drift control is achieved by observing weather conditions and following label and sprayer instructions. Spray droplet size should be 150 microns or larger.

Restrictions/Warnings/Limitations: Non-selective herbicide—apply to target plants only. Unless labeled for aquatic use, do not apply directly to water or to areas where surface water is present. Corrosive to unlined and galvanized steel. T&E warning for plants.

III. ENVIRONMENTAL EFFECTS/FATE

SOIL:

RESIDUAL SOIL ACTIVITY: The half-life of glyphosate is 47 days.

ADSORPTION: The K(oc) of glyphosate is 24,000.

PERSISTENCE AND AGENTS OF DEGRADATION: Glyphosate is moderately persistent in the plant. The primary route of degradation is microbial activity.

METABOLITES/DEGRADATION PRODUCTS AND POTENTIAL ENVIRONMENTAL EFFECTS: The primary metabolite of glyphosate is aminomethylphosphonic acid. Environmental effects similar to parent chemical.

WATER:

SOLUBILITY: 11,600 mg/l in water (pH 7 at 25° C).

POTENTIAL FOR LEACHING INTO SURFACE AND GROUND WATER: Glyphosate is moderately persistent with a very high soil adsorption coefficient. It is not expected to leach or otherwise migrate from the site of application.

AIR:

VOLATILIZATION: Very low.

POTENTIAL FOR BYPRODUCTS FROM BURNING OF TREATED VEGETATION: None.

IV. ECOLOGICAL TOXICITY EFFECTS ON NON-TARGET SPECIES

For Glyphosate Formulations Labeled for Terrestrial Uses

MICROORGANISMS:

ACUTE CONTACT TOXICITY: LD₅₀ (honey bee contact) >100 µg/bee

OVERALL TOXICITY: Practically Non-Toxic

PLANTS: Contact will injure or kill target and non-target plants.

AQUATIC VERTEBRATES:

ACUTE TOXICITY: LC₅₀ (rainbow trout 96-hour) 8.2 mg/l

ACUTE TOXICITY: LC₅₀ (bluegill sunfish 96-hour) 5.8 mg/l

ACUTE TOXICITY: LC₅₀ (chinook salmon 96-hour) 20 mg/l

ACUTE TOXICITY: LC₅₀ (coho salmon 96-hour) 22 mg/l

OVERALL TOXICITY: Moderately Toxic

AQUATIC FRESHWATER INVERTEBRATES:

ACUTE TOXICITY: LC₅₀ (*Daphnia magna* 48-hour) 24 mg/l

OVERALL TOXICITY: Slightly Toxic

AQUATIC ESTUARINE/MARINE INVERTEBRATES:

ACUTE TOXICITY: LC₅₀ (fiddler crab 96-hour) 934 mg/l

ACUTE TOXICITY: LC₅₀ (grass shrimp 96-hour) 281 mg/l

OVERALL TOXICITY: Practically Non-Toxic

TERRESTRIAL ANIMALS:

AVIAN ACUTE ORAL TOXICITY: LD₅₀ (bobwhite quail) >2000 mg/kg

AVIAN ACUTE ORAL TOXICITY: LD₅₀ (mallard duck) >2251 mg/kg

AVIAN SUBACUTE DIETARY TOXICITY: LC₅₀ (bobwhite quail) >6300 mg/kg

AVIAN SUBACUTE DIETARY TOXICITY: LC₅₀ (mallard duck) >6300 mg/kg

MAMMAL ACUTE ORAL TOXICITY: LD₅₀ (goat) >5000 mg/kg

OVERALL TOXICITY: Practically Non-Toxic

BIOACCUMULATION POTENTIAL: Little or No Potential

For Glyphosate Formulations Labeled for Aquatic/Terrestrial Uses

MICROORGANISMS:

ACUTE CONTACT TOXICITY: LD₅₀ (honey bee contact) >100 µg/bee

OVERALL TOXICITY: Practically Non-Toxic

PLANTS: Contact will injure or kill target and non-target plants.

AQUATIC VERTEBRATES:

ACUTE TOXICITY: LC₅₀ (rainbow trout 96-hour) >1000 mg/l

ACUTE TOXICITY: LC₅₀ (bluegill sunfish 96-hour) >1000 mg/l

OVERALL TOXICITY: Practically Non-Toxic

AQUATIC FRESHWATER INVERTEBRATES:

ACUTE TOXICITY: LC₅₀ (*Daphnia magna* 48-hour) 930 mg/l

OVERALL TOXICITY: Practically Non-Toxic

AQUATIC ESTUARINE/MARINE INVERTEBRATES:

ACUTE TOXICITY: LC₅₀ (Eastern oyster larvae 48-hour) >10 mg/l

ACUTE TOXICITY : LC₅₀ (fiddler crab 96-hour) 934 mg/l

ACUTE TOXICITY: TL₅₀ (grass shrimp 96-hour) >281 mg/l

OVERALL TOXICITY: Slightly Toxic

TERRESTRIAL ANIMALS:

AVIAN ACUTE ORAL TOXICITY: LD₅₀ (bobwhite quail) >2000 mg/kg

AVIAN SUBACUTE DIETARY TOXICITY: LC₅₀ (bobwhite quail) >4640 mg/kg

AVIAN SUBACUTE DIETARY TOXICITY: LC₅₀ (mallard duck) >4640 mg/kg

MAMMAL ACUTE ORAL TOXICITY: LD₅₀ (goat) >5000 mg/kg

OVERALL TOXICITY: Practically Non-Toxic

BIOACCUMULATION POTENTIAL: Little or No Potential

THREATENED AND ENDANGERED SPECIES: Federally listed terrestrial and aquatic plants may be adversely affected if the product is applied directly to the plants, or indirectly as the result of drift or leaching.

V. TOXICOLOGICAL DATA

ACUTE TOXICITY:

ACUTE ORAL TOXICITY: LD₅₀ (rat) >4320 mg/kg

ACUTE DERMAL TOXICITY: LD₅₀ (rabbit) >2000 mg/kg

PRIMARY SKIN IRRITATION: Rabbit - Slight Irritant

PRIMARY EYE IRRITATION: Rabbit – Mild Irritant

ACUTE INHALATION: Not required by EPA.

OVERALL TOXICITY: Category III – Slightly Toxic

CHRONIC TOXICITY:

CARCINOGENICITY: Classified as a Group E chemical: Evidence of non-carcinogenicity for humans.

DEVELOPMENTAL/REPRODUCTIVE: Some effects at highest dose levels.

MUTAGENICITY: No effects.

HAZARD: The end-use product labels for glyphosate formulations without ethoxylated tallowamines carry the *Caution* signal word due to potential eye irritation.

The end-use product labels for glyphosate formulations with ethoxylated tallowamines carry the *Warning* signal word by causing substantial but temporary eye injury.

VI. HUMAN HEALTH EFFECTS

ACUTE TOXICITY (POISONING):

REPORTED EFFECTS: Glyphosate formulations will cause reversible eye injury. Will cause hypotension and lung edema if ingested in large quantities.

CHRONIC TOXICITY:

REPORTED EFFECTS: Decreased body weight, decreased food consumption, increased white blood cells, decreased liver weight and increased relative brain weights were observed in test animals.

POTENTIAL FOR ADVERSE HEALTH EFFECTS FROM CONTACTING OR CONSUMING TREATED VEGETATION, WATER OR ANIMALS: EPA reports no toxicological endpoints of concern..

POTENTIAL FOR ADVERSE HEALTH EFFECTS FROM INERT INGREDIENTS CONTAINED IN THE FORMULATED PRODUCTS: None reported.

HEALTH EFFECTS OF EXPOSURE TO FORMULATED PRODUCTS: The results of a single exposure (acute) toxicity studies conducted on formulations containing ethoxylated tallowamines indicate that these materials are no more than moderately toxic in rats after ingestion or in rabbits after skin application. The formulation is severely irritating to corrosive to rabbit eyes and can be irritating to rabbit skin.

HEALTH EFFECTS ASSOCIATED WITH CONTAMINANTS: None reported.

HEALTH EFFECTS ASSOCIATED WITH OTHER FORMULATIONS: None reported.

VII. SAFETY PRECAUTIONS

SIGNAL WORD AND DEFINITION:

GLYPHOSATE - **CAUTION** – CAUSES EYE IRRITATION

GLYPHOSATE WITH ETHOXYLATED TALLOWAMINES - **WARNING** - CAUSES
SUBSTANTIAL BUT TEMPORARY EYE INJURY

PROTECTIVE PRECAUTIONS FOR WORKERS: Applicators and other handlers must wear long-sleeved shirt and long pants, shoes plus socks; for the ethoxylated tallowamine formulations, the user must also wear protective eyewear.

MEDICAL TREATMENT PROCEDURES (ANTIDOTES):

EYES: Flush eyes with water for 15 minutes and call physician.

SKIN: Wash all exposed areas with soap and water, call physician if irritation persists.

INGESTION: Rinse mouth thoroughly with water. Do not induce vomiting. Call physician.

INHALATION: None normally needed.

HANDLING, STORAGE AND DISPOSAL: Store at room temperature or cooler. Do not reuse container. Rinse container and dispose accordingly.

EMERGENCY SPILL PROCEDURES AND HAZARDS: Contain and sweep up material of small spills and dispose as waste. Do not contaminate water, food, or feed by storage or disposal.

VIII. DEFINITIONS

adsorption – the process of attaching to a surface

avian – of, or related to, birds

CAEPA – California Environmental Protection Agency

carcinogenicity – ability to cause cancer

CHEMTREC – Chemical Transportation Emergency Center

dermal – of, or related to, the skin

EC₅₀ - median effective concentration during a bioassay

ecotoxicological – related to the effects of environmental toxicants on populations of organisms originating, being produced, growing or living naturally in a particular region or environment

FIFRA – Federal Insecticide, Fungicide and Rodenticide Act

formulation – the form in which the pesticide is supplied by the manufacturer for use

half-life – the time required for half the amount of a substance to be reduced by natural processes

herbicide – a substance used to destroy plants or to slow down their growth

Hg – chemical symbol for mercury

IARC – International Agency for Research on Cancer

K(oc) – the tendency of a chemical to be adsorbed by soil, expressed as: $K(oc) = \text{conc. adsorbed}/\text{conc. dissolved}/\% \text{ organic carbon in soil}$

LC₅₀ – the concentration in air, water, or food that will kill approximately 50% of the subjects

LD₅₀ – the dose that will kill approximately 50% of the subjects

leach – to dissolve out by the action of water

mg/kg – weight ratio expressed as milligrams per kilogram

mg/l – weight-to-liquid ratio expressed as milligrams per liter

microorganisms – living things too small to be seen without a microscope

mPa – milli-Pascal (unit of pressure)

mutagenicity – ability to cause genetic changes

NFPA – National Fire Protection Association

NIOSH - National Institute for Occupational Safety and Health

NOEL - no observable effect level

non-target – animals or plants other than the ones that the pesticide is intended to kill or control

OSHA - Occupational Safety and Health Administration

Pa – Pascal (unit of pressure)

persistence – tendency of a pesticide to remain to remain in the environment after it is applied

pesticides – substances including herbicides, insecticides, rodenticides, fumigants, repellents, growth regulators, etc., regulated under FIFRA

PPE – personal protective equipment

ppm – weight ratio expressed as parts per million

residual activity – the remaining amount of activity as a pesticide

T&E – Threatened and Endangered Species (from the Endangered Species Act)

µg – micrograms

volatility – the tendency to become a vapor at standard temperatures and pressures

IX. INFORMATION SOURCES

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X. TOXICITY CATEGORY TABLES

TABLE I: HUMAN HAZARDS

Category	Signal Word	Route of Administration			Hazard	
		Acute Oral LD ₅₀ (mg/kg)	Acute Dermal LD ₅₀ (mg/kg)	Acute Inhalation LC ₅₀ (mg/l)	Eye irritation	Skin irritation
I (Highly Toxic)	DANGER (poison)	0-50	0-200	0-0.2	corrosive: corneal opacity not reversible within 7 days	corrosive
II (Moderately Toxic)	WARNING	>50-500	>200-2000	>0.2-2	corneal opacity reversible within 7 days; irritation persisting for 7 days	severe irritation at 72 hours
III (Slightly Toxic)	CAUTION	>500-5000	>2000-20.000	>2-20	no corneal opacity; irritation reversible within 7 days	moderate irritation at 72 hours
IV (Practically Non-toxic)	NONE	>5000	>20,000	>20	no irritation	moderate irritation at 72 hours

After *Pesticide User's Guide*, Ohio State University, Extension Bull. No. 745, 1998.

TABLE II: ECOTOXICOLOGICAL RISKS TO WILDLIFE (TERRESTRIAL AND AQUATIC)

Risk Category	Mammals	Avian	Avian	Fish or Aquatic Invertebrates
	Acute Oral LD ₅₀ (mg/kg)	Acute Oral LD ₅₀ (mg/kg)	Acute Dietary LC ₅₀ (mg/kg)	Acute Concentration LC ₅₀ (mg/l)
Very Highly Toxic	<10	<10	<50	<0.1
Highly Toxic	10-50	10-50	50-500	0.1 – 1
Moderately Toxic	51-500	51-500	501-1,000	>1 – 10
Slightly Toxic	501-2,000	501-2,000	1,001-5,000	>10 – 100
Practically Non-toxic	>2,000	>2,000	>5,000	>100

Table II created from information contained in *Pesticides and Wildlife*, Whitford, Fred, et al., Purdue University Cooperative Extension Service PPP-30, 1998.

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