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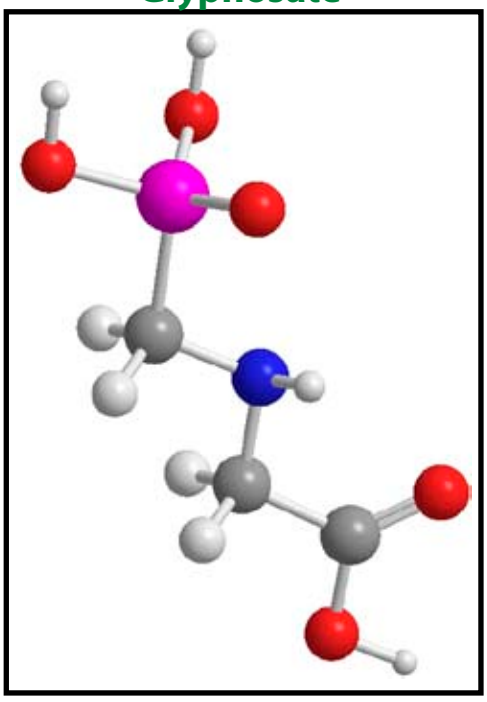
Thank you for visiting the National Pesticide Information Center's fact sheets.

Some of the information in the following fact sheet (scroll down) is out-of-date. NPIC has started a *NEW* set of fact sheets, and glyphosate is high on our list of priorities. If you would like to be notified when NPIC releases new publications, send an email to npicupdates@ace.orst.edu with "subscribe" in the subject line.

Check out our new technical fact sheet on resmethrin!

Please call NPIC with any questions you have about pesticides at **1-800-858-PEST (7378)**.

Molecular Structure - Glyphosate



NPTN General Fact Sheets are designed to answer questions that are commonly asked by the general public about pesticides that are regulated the U.S. Environmental Protection Agency (US EPA). This document is intended to be helpful to professionals and to the general public for making decisions about pesticide use.

National Pesticide Telecommunications Network

Glyphosate

(General Fact Sheet)

Please refer to the **Technical Fact Sheet** for more technical information.

The Pesticide Label: Labels provide directions for the proper use of a pesticide product. *Be sure to read the entire label before using any product.* A signal word, on each product label, indicates the product's potential hazard.

CAUTION - low toxicity **WARNING - moderate toxicity** **DANGER - high toxicity**

What is glyphosate?

- Glyphosate is a herbicide (kills or controls weeds) registered by the U.S. Environmental Protection Agency (EPA) in 1974 and reregistered in 1993 (1, 2).
- Glyphosate is nonselective. Users apply it directly to foliage to control plants (3). See the **Herbicide Selectivity** box.
- Different forms of glyphosate (acid and salt) are used in products. Use of the term "glyphosate" in this fact sheet refers to the acid or salts.
- Glyphosate is water soluble, odorless, and nonvolatile (3, 4).

Herbicide Selectivity: Selective herbicides kill some plant species and not others. No plants are known to be naturally resistant to the action of glyphosate. Scientists have genetically altered some crop plants to be resistant to the effects of glyphosate, allowing glyphosate to be used as a selective herbicide in these fields.

- Signal words for products containing glyphosate range from Caution to Danger (2, 5). The signal word reflects the combined toxicity of glyphosate and other ingredients in each product. See the **Pesticide Label** box above.
- Scientists have modified some plants to be resistant to glyphosate. Glyphosate-tolerant soybeans are an example of such a plant (6). **This fact sheet does not address glyphosate-tolerant crops.**
- Glyphosate products are used to treat crops, forests, bodies of water, roadside areas, and public and private yards (2). Products containing glyphosate come in various forms including granules, powders, aerosols, and liquids (5).

How does glyphosate work?

- Glyphosate acts by inhibiting a biochemical pathway important in the normal functioning of plants. By disrupting the pathway, compounds necessary for the plant's survival can not be made. This biochemical pathway is found only in plants and microorganisms (7).

- Glyphosate crosses the plant surface and moves throughout the plant. The chemical accumulates in actively-growing parts of the plant (3, 7).

- Plants exposed to glyphosate display stunted growth, green color loss, and wrinkled leaves. Plant death may take several days to weeks to occur (3, 7).

What are some products that contain glyphosate?

- Roundup®
- Rodeo®
- Accord®
- Touchdown®

How toxic is glyphosate?

Animals

- Glyphosate is low in toxicity when eaten, inhaled, or applied to the skin (2, 4). See boxes on **Laboratory Testing**, **LD50/LC50,** and **Toxicity Category**.

- Glyphosate caused slight to no skin irritation in rabbits and did not cause skin sensitization in guinea pigs (8).

- Glyphosate caused strong to no eye irritation in rabbits (8). The U.S. EPA categorizes the ability of glyphosate to irritate the eye as low. This is based on a study where rabbits exposed to glyphosate experienced mild eye irritation that cleared (2).

- Scientists fed mice glyphosate for 90 days and detected reduced body weight gains at the highest dose. They did not detect adverse effects at lower doses (2).

- Researchers fed dogs glyphosate for 1 year and detected no adverse effects (2, 8, 9).

Exposure: Effects of glyphosate on human health and the environment depend on how much glyphosate is present and the length and frequency of exposure. Effects also depend on the health of a person and/or certain environmental factors.

Laboratory Testing: Before pesticides are registered by the U.S. EPA, they must undergo laboratory testing for short-term (acute) and long-term (chronic) health effects. Laboratory animals are purposely fed high enough doses to cause toxic effects. These tests help scientists judge how these chemicals might affect humans, domestic animals, and wildlife in cases of overexposure. When pesticide products are used according to the label directions, toxic effects are not likely to occur because the amount of pesticide that people and pets may be exposed to is low compared to the doses fed to laboratory animals.

- Laboratory workers exposed the skin of rabbits to glyphosate for 21 days and noted slight skin swelling and redness at the highest dose (8, 9).

Humans

- Doctors reviewed cases of accidental and intentional exposures to glyphosate products. Exposures to the skin did not result in symptoms. Humans who drank glyphosate products experienced digestive tract irritation, low blood pressure, and respiratory dysfunction. Symptoms from accidentally drinking glyphosate disappeared within 24 hours. Some people who intentionally drank glyphosate products died (10).

- Researchers proposed that the symptoms and fatalities resulting from drinking glyphosate products may be caused by an ingredient other than glyphosate in the products (11).

Toxicity Category (*Signal Word*) (12)

	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	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 mg/l	Greater than 2 mg/l
Eye Effects	Corrosive	Irritation persisting for 7 days	Irritation reversible within 7 days	Minimal effects, gone within 24 hrs
Skin Effects	Corrosive	Severe irritation at 72 hours	Moderate irritation at 72 hours	Mild or slight irritation

LD50/LC50: A common measure of acute toxicity is the lethal dose (LD50) or lethal concentration (LC50) that causes death (resulting from a single or limited exposure) in 50 percent of the treated animals. LD50 is generally expressed as the dose in milligrams (mg) of chemical per kilogram (kg) of body weight. LC50 is often expressed as mg of chemical per volume (e.g., liter (L)) of medium (i.e., air or water) the organism is exposed to. Chemicals are considered highly toxic when the LD50/LC50 is small and practically non-toxic when the value is large. However, the LD50/LC50 does not reflect any effects from long-term exposure (i.e., cancer, birth defects, or reproductive toxicity) that may occur at levels below those that cause death.

- No skin irritation occurred on human volunteers who had a diluted glyphosate product applied to their skin. Researchers noted skin redness in volunteers treated with an undiluted glyphosate product. No skin sensitization occurred with human volunteers who had an undiluted glyphosate product applied to their skin (8). Glyphosate is absorbed poorly through the skin (2).

- Scientists evaluated effects from human eye exposures to glyphosate products. The majority of exposures resulted in no injury or temporary minor effects. Moderate effects were noted in a small percentage of cases and involved symptoms that usually required medical treatment. None of the exposures resulted in permanent eye damage or loss of vision (13).

Does glyphosate cause reproductive or birth defects?

Animals

- Researchers noted no fertility effects nor toxicity in adult rats fed glyphosate continuously for three generations (2, 9, 14). No effects in the offspring were attributed to glyphosate exposure (2, 9).

- In a two-generation study, laboratory workers fed rats glyphosate and noted decreased body weight gain in offspring at the highest dose tested. Workers detected no developmental effects at lower doses. No fertility effects were observed in the study (2, 9).

- Researchers exposed pregnant rats to glyphosate by stomach tube feeding. At the highest dose, the mother rats displayed decreased body weight gains and more deaths, and the offspring had decreased body weights and an increased number of malformations. Researchers noted no effects to the mothers rats or offspring at lower doses (2, 8, 9, 14).

- Scientists exposed pregnant rabbits to glyphosate by stomach tube feeding and detected no developmental effects. At the highest dose the mother rabbits had diarrhea and more deaths. Scientists noted no effects to the mother rabbits at lower doses (2, 8, 9, 14).

Humans

- Data are not available from accidental poisonings, work-related exposures, or other human studies regarding the reproductive and developmental toxicity of glyphosate.

Does glyphosate cause cancer?

Animals

- Laboratory workers fed rats diets containing glyphosate for 2 years. Workers noted tumors at a variety of doses with the tumors failing to progress to cancer. The tumors are not believed to be related to glyphosate exposure (2, 9).

- Researchers fed male and female mice glyphosate for 18 months and at the highest dose detected decreased body weight gains in both male and female mice and an increased number of kidney tumors in males. The increased number of kidney tumors detected at the highest dose was not significantly greater than the number found in unexposed mice (2, 9).

- Researchers often test chemicals for their ability to change the genetic material of an organism as an indication of the chemical's potential to cause cancer. Evidence exists that glyphosate does not change genetic material (2, 8, 9, 14).

Humans

- The U.S. EPA currently classifies glyphosate as a group E carcinogen (2, 9, 15). This means that glyphosate is not believed to cause cancer because it did not cause cancer in laboratory animals. See box on **Cancer**.

- Researchers suggested glyphosate exposure possibly increases the risk for cancer, but definitive conclusions could not be reached due to small sample sizes and confounding factors (16, 17).

Cancer: The U.S. EPA has strict guidelines that require testing of pesticides for their potential to cause cancer. These studies involve feeding laboratory animals large *daily* doses of the pesticide over most of the lifetime of the animal. Based on these tests, and any other available information, EPA gives the pesticide a rating for its potential to cause cancer in humans. For example, if a pesticide does not cause cancer in animal tests at large doses, then the EPA considers it unlikely the pesticide will cause cancer in humans. Testing for cancer is not done on human subjects.

What happens to glyphosate in the environment?

- Glyphosate is stable to breakdown by water and sunlight (2, 18). The major way glyphosate breaks down in the environment is by microorganisms, particularly in soil (2, 8, 18).

- The persistence of glyphosate in soils ranges from low to moderate (8).

- Glyphosate strongly binds to soil and has a low potential to contaminate ground water (2, 8).

- Glyphosate may adversely affect nontarget plants. When in soil, glyphosate's strong soil binding limits its toxicity to plants (3).

What effects does glyphosate have on wildlife?

- Glyphosate is slightly to practically nontoxic to fish (2). Some glyphosate products, due to the toxicity of another ingredient, must bear the statement, "This pesticide is toxic to fish." (2). Glyphosate is not likely to accumulate in fish (2, 8).

- Glyphosate is practically nontoxic to birds and honeybees (2).

- Glyphosate has low toxicity to earthworms (8).

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