

What is glyphosate?

Glyphosate is a type of pesticide, known as an herbicide. Herbicides damage or kill plants. Glyphosate is a broad-spectrum herbicide, meaning it affects both grasses and broadleaf plants. It was first registered for use in the US in 1974 and is currently the most widely used pesticide in the world.

How is glyphosate used in Vermont?

Glyphosate-containing products, such as Roundup®, are used to control many different types of weeds in many different settings in Vermont, such as:

- * Agricultural practices, such as terminating cover crops for water quality practices
- * Weed control in ornamental plantings, lawn, turf, invasive plant control, and right-of-way maintenance
- * Weed control in genetically engineered (GE) crop production, such as corn and soybeans

In Vermont, glyphosate-containing products can be used by homeowners, farmers, and commercial applicators, making it difficult to estimate statewide usage. However, it is one of the most commonly used herbicides in Vermont and usage could go up as water quality conservation practices increase statewide.

How does glyphosate work?

Glyphosate works by blocking a plant's ability to make certain proteins. When this happens, the plant cannot grow, and it dies. For glyphosate to work, it must be applied to actively growing plants.

How is glyphosate evaluated for safety?

In the US, the Environmental Protection Agency (EPA) evaluates and registers pesticides for use. During registration, the EPA uses a scientific process to evaluate risks to human health and the environment. One part of the process is toxicity testing. Toxicity, or how poisonous a chemical is, is measured by the median lethal dose, the "LD50."

The LD50 is the amount of a substance needed to kill 50% of a test population of animals. The substance can be given to the test population in a variety of ways, such as by feeding (oral), by placing on the skin (dermal), or by air (inhalation).

Generally, an LD50 is expressed as milligrams of the substance per kilogram of animal body weight. The lower the LD50, the more toxic the substance.

The EPA also looks at risks in the short-term (acute), long-term (chronic), and even those in between (sub-chronic) in this process. The potential carcinogenicity (ability to cause cancer) is another risk evaluated. After all the tests are done, the EPA determines if, and how, it can manage risks to humans and the environment from the pesticide, while balancing the economic and social benefits. A product's label will reflect the entire assessment through the directions for use and ways to reduce exposure, such as personal protective equipment (PPE), limitations, and restrictions on sales and use.

What happens to glyphosate in the environment?

Glyphosate sticks tightly to soil and has a relatively short half-life, making it unlikely to be found in ground and surface water. It can remain in soil for up to 6 months, depending on the climate and soil type. Glyphosate breaks down into its primary metabolite, aminomethylphosphonic acid (AMPA) by bacteria in the soil.

Glyphosate has been shown to have low toxicity on birds, mammals, fish, and invertebrates. However, some products that contain glyphosate may be more toxic to these because of other ingredients.

The Vermont Agency of Agriculture, Food & Markets has been testing for glyphosate and AMPA in Vermont to better understand its impact on our environment. To date, the Agency has test results for over 290 ground and surface water samples for glyphosate and AMPA. Neither have been found in any sample (Table 1).

Table 1. Ground and surface water samples tested for glyphosate and AMPA by county in Vermont, 2006-2018 (as of 12/1/2018)

| County | Number of samples |
|--------------|-------------------|
| Addison | 26 |
| Caledonia | 56 |
| Chittenden | 14 |
| Essex | 2 |
| Franklin | 91 |
| Grand Isle | 8 |
| Orange | 12 |
| Orleans | 29 |
| Rutland | 7 |
| Washington | 40 |
| Windsor | 5 |
| TOTAL | 290 |

Is glyphosate safe?

Glyphosate can be used safely if used according to the label. Glyphosate is relatively non-toxic to hu-

mans. Many household products are more toxic than glyphosate; for example, caffeine, table salt, and nicotine are all more toxic than glyphosate (Table 2).

Glyphosate is used on crops, are they safe to eat?

Glyphosate is used on a variety of fruit, grain, and vegetable crops, including certain genetically engineered crops and other non-genetically engineered crops. The use of glyphosate on these crops is also evaluated for risks to human health when they are added to the pesticide label. The EPA determined that if the products are used according to the label, these foods are safe to eat.

What about recent reports that glyphosate was found in food/drink?

As it is widely used, trace amounts of glyphosate may be found in various food and beverage products. This type of potential exposure is

Table 2. ACUTE TOXICITY: Life-threatening one-time doses

| Substance | Found In | Lethal Dose (LD50) | Toxicity |
|-------------------|--------------------------------|--------------------|--------------------------------------|
| Water | Water | 90,000 | Practically non-toxic (>5,000 mg/kg) |
| Sucrose | Table sugar | 29,700 | |
| Ethanol | Beer, wine, spirits | 7,060 | |
| Calcium carbonate | Antacids | 6,450 | |
| Glyphosate | Herbicide (Roundup®) | 4,900 | Slightly (500 - 5,000 mg/kg) |
| Sodium chloride | Table salt | 3,000 | |
| Acetaminophen | Tylenol | 1,944 | |
| 2,4-D | Herbicide | 666 | |
| Codeine | Pain killer, cough suppressant | 427 | Moderately (50 - 500 mg/kg) |
| Copper sulfate | Organic fungicide | 300 | |
| Caffeine | Coffee, tea, soda | 192 | |
| Rotenone | Organic insecticide | 60 | |
| Vitamin D3 | Supplements | 42 | Highly (1 - 50 mg/kg) |
| Nicotine | Cigarettes | 9 | |
| Hydrogen cyanide | Fruit pits | 4 | |
| Botulinum toxin | Botox | <0.001 | |

*University of Florida Pesticide Information Office, <http://fafdl.org/gmobb/6-of-17-is-glyphosate-an-especially-dangerous-pesticide/> and the NIH TOXNET Database, <https://toxnet.nlm.nih.gov/> compares the toxicity of herbicides and household items. The lower the LD50 value (the dose at which half of lab animals [rats, oral] die), the more toxic the substance.

considered in the EPA's assessment. The conclusion is that these do not pose a risk to human health. The World Health Organization (WHO) agrees with this conclusion. The EPA has determined the acceptable limit for glyphosate on food to be 1 milligram per kilogram of body weight per day. The trace amounts recently found in foods (~0.02 milligrams per serving) are well below the EPA's acceptable limit. For an average person weighing 65 kilograms, you would have to eat 430 pounds of oats *a day*. Keep in mind that other ingredients in foods may be more toxic, like caffeine and table salt.

Does glyphosate cause cancer?

In 2015, the International Agency for Research on Cancer (IARC), a division of the WHO, classified glyphosate as "probably carcinogenic to humans (Group 2A)." After this news, the EPA conducted a re-evaluation of all the available data and stated that glyphosate is "not likely to be carcinogenic to humans at doses relevant for human health risk assessment."

Furthermore, in 2016 the EPA consulted with an independent Scientific Advisory Panel for a review of both its conclusion and the process they used to reach the conclusion. The review by independent scientists and academics supported the EPA's process and conclusion.

Why the difference between IARC and EPA? How are there different answers?

EPA's cancer classification for glyphosate is based on a weight of evidence assessment. The data used by the EPA included studies submitted for registration of glyphosate, as well as those in the open scientific literature. IARC only uses data that have been published, or accepted for publication, in open scientific literature. As a result, the IARC only used a subset of the cancer studies.

It is not unusual in this field of science to use different methodologies and occasionally reach different conclusions. The EPA's assessment is consistent with many other countries and regulatory authorities' current and recent assessments, including Canada, Australia, the European Food Safety Authority, Germany, the Joint FAO/WHO Meeting on Pesticide Residues, European Chemicals Agency, Japan, and New Zealand.

Is there a link between glyphosate and Parkinson's disease or non-Hodgkin's lymphoma?

The EPA's review of the scientific data, including glyphosate data from the Agricultural Health Study, does not support a cause and effect relationship between exposure to glyphosate and Parkinson's disease or non-Hodgkin's lymphoma.

What if the data changes?

Every 15 years the EPA re-evaluates pesticide risks using updated scientific research data. Currently glyphosate is in this process.

In Vermont, the Agency of Agriculture regulates pesticide use, and it does so on the best available scientific data. In its regulation, it considers the risks to Vermonters and our environment. If scientific data indicate an increased risk to either, the Agency will work with its state and federal partners to lessen the risk.

References and Resources

Duke, S. 2017. *The history and current status of glyphosate*. Pest Management Science 2018; 74:1027-1034

Environmental Protection Agency: <https://www.epa.gov/ingredients-used-pesticide-products/draft-human-health-and-ecological-risk-assessments-glyphosate>

EPA factsheet: www.epa.gov/ingredients-used-pesticide-products/glyphosate

Health Canada's PMRA: www.canada.ca/en/health-canada/corporate/about-health-canada/branches-agencies/pest-management-regulatory-agency.html

IARC monograph on glyphosate: www.iarc.fr/featured-news/media-centre-iarc-news-glyphosate/

National Pesticide Information Center: <http://npic.orst.edu/ingred/glyphosate.html>

The European Food Safety Authority: www.efsa.europa.eu/en/topics/topic/glyphosate