

chemicalWATCH Factsheet

GLYPHOSATE

Despite widespread use of the weed killer glyphosate and the prevalent myth that it is harmless, this pesticide is tied to acute human health effects and linked to non-Hodgkin's lymphoma. It is found in two Monsanto products, available over the counter, Roundup™ and Rodeo™, making glyphosate one of the most widely used and well-known herbicides on the market. Due to the string consumer line and the company's genetically engineered (GE) "Roundup Ready" crops, glyphosate is the most widely used pesticide in the U.S.¹ As of 2005, 87% of U.S. soybean fields were planted with glyphosate resistant varieties.² If there is one pesticide that represents the "fast-food," quick-fix generation, glyphosate would likely be it – the McPesticide of toxic chemicals.

General Use

Glyphosate (N-phosphono-methyl glycine), according to the Environmental Protection Agency's (EPA) most recent data on pesticide usage, was the seventh most widely used active ingredient in agriculture, with 34 to 38 million pounds used in 1997.³ In 1995/96, glyphosate ranked as the second most used active ingredient in non-agricultural settings, with five to seven million pounds used in the home and garden and nine to twelve million pounds used in commercial settings.⁴ Glyphosate use is currently growing at a rate of about 20 percent per year, due in large part to the growing number of genetically engineered crops that are resistant to the herbicide.⁵ With this growth rate, it is estimated that as much as 100 million pounds of glyphosate was applied in 2000. Of course these numbers fail to reflect the poundage of inert ingredients in the formulations that are mixed with the glyphosate.

First registered for use in 1974, there are 63 glyphosate-containing pesticide

formulations registered for use in the U.S. The isopropylamine salt of glyphosate, the active ingredient in 53 of these products, is used to kill a variety of broadleaf weeds and grasses. The principal agricultural uses include corn, wheat, sorghum, citrus and stone fruits, potatoes, onions, asparagus, coffee, peanuts and pineapple.⁶ There are also a good number of non-food uses including ornamental, turf, forestry, Christmas tree production and rights-of-way.⁷

Some of the most widespread uses of glyphosate that have been attracting public attention include use in invasive weed management and home gardening. The increase of glyphosate use in these areas is directly tied to the larger problem of poor land management, including over grazing, over development, soil compaction and other stressors. Glyphosate has replaced ecologically sound and sustainable cultural practices such as green-mulching, and preventive maintenance such as aeration and dethatching.

Mode of Action

Plants treated with glyphosate translocate the systemic herbicide to their roots, shoot regions and fruit, where it interferes with the plant's ability to form aromatic amino acids necessary for protein synthesis. Treated plants generally die in two to three days. Because plants absorb glyphosate it cannot be completely removed by washing or peeling produce or by milling, baking or brewing grains. It has been shown to persist in food products for up to two years.⁸

Inert Ingredients

A letter published in the February 6, 1988 *Lancet* (page 299) cited a Japanese report of 56 cases of toxic exposure to Roundup™ between June, 1984 and March, 1986. The individuals had ingested the pesticide, and experienced a

range of adverse effects to their respiratory, cardiovascular, and central nervous systems; nine patients died. An analysis of the findings identified one of the so-called "inert ingredients" (inerts) in the formulation, polyoxyethyleneamine (POEA), as the cause of harm. POEA is a surfactant, a chemical added to help glyphosate work its way into the plant tissue. Roundup™ contains 15% POEA.

In 2009, French researchers found that one of the inert ingredients Roundup can kill human cells, particularly embryonic, placental and umbilical cord cells.⁹

All pesticide formulations are actually toxic soups, a mixture of the active ingredient (the registered pesticide) with a variety of other chemicals such as solvents, surfactants (like POEA), and emulsifiers – the inerts. Federal law classifies inerts as trade secrets and pesticide manufacturers are not required to list inert ingredients on the pesticide label. Inerts, which can make up to as much as 99% of a pesticide formulation, are often highly toxic chemicals that can be more hazardous than the active ingredient.

Inerts known to be included in glyphosate products include ammonium sulfate, benziothiazolone, 3-iodo-2-propynyl butylcarbamate (IPBC), isobutane, methyl pyrrolidinone, pelargonic acid, sodium sulfite, sorbic acid, and isopropylamine. All of these chemicals are associated with skin irritation, gastric and respiratory problems.¹⁰

Acute Exposure

While EPA considers glyphosate to be "of relatively low oral and dermal acute toxicity,"¹¹ the agency does classify glyphosate in toxicity class II (class I chemicals are the most toxic in a scale from I-IV). Some glyphosate products are of higher acute

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toxicity, primarily due to eye and/or skin irritation.

A 2008 study by the National Institute for Occupational Safety and Health (NIOSH) finds the pesticide poisoning incidence rate among U.S. agricultural workers is thirty-nine times higher than the incidence rate found in all other industries combined. Glyphosate was one of 17 pesticide implicated in the study.¹² In California, 1998 data from the state's Department of Pesticide Regulation finds that glyphosate ranks first among herbicides as the highest causes of pesticide-induced illness or injury.¹³

Beyond Pesticides' own pesticide incident reporting system has received numerous reports of people poisoned by exposure to glyphosate from around the country. These victims of pesticide exposure suffered from eye soreness, headaches, diarrhea, and other flu-like symptoms.

Symptoms following exposure to glyphosate formulations include: swollen eyes, face and joints; facial numbness; burning and/or itching skin; blisters; rapid heart rate; elevated blood pressure; chest pains, congestion; coughing; headache; and nausea.¹⁴

In developmental toxicity studies using pregnant rats and rabbits, glyphosate caused treatment-related effects in high dose groups, including diarrhea, decreased body weight gain, nasal discharge and death.¹⁵

Chronic Exposure

One reproductive study using rats found kidney effects in the high dose group while another study showed digestive effects and decreased body weight gain.¹⁶

A cancer study looking at rats found an increase in pancreas and liver tumors in males as well as an increase in thyroid cancer in females.¹⁷

A 1999 study, *A Case-Control Study of Non-Hodgkin Lymphoma and Exposure to Pesticides*, (American Cancer Society, 1999), found that people exposed to glyphosate are 2.7 times more likely to contract non-Hodgkin Lymphoma.

A Finnish study shows that glyphosate decreases the defenses of enzymes of the liver and intestines.¹⁸ RoundUp, as a mixture of all its ingredients, has been shown to shut down a powerful antioxidant in the liver that detoxifies harmful compounds so they can be excreted through bile. A paper published in August 2000 shows that RoundUp alters gene expression and inhibits necessary steroid production by disrupting a particular protein expression. In 2002, a paper shows that RoundUp can also affect early cell division processes in embryos.¹⁹

There has been controversy regarding whether glyphosate at high doses causes tumors of the thyroid and testes in rats. EPA has reported that technical glyphosate is contaminated with "less than 100 parts-per-billion" of N-nitroso-glyphosate (NNG), a by-product of synthesis. Many N-nitroso compounds are animal carcinogens. EPA is not, however, requiring further investigation of the toxicological effects of NNG, because it does not typically require data on N-nitroso contaminants present at levels of less than one part-per-million.

Environmental Effects

Much of the belief about glyphosate's environmental safety is based on the

expectation that residues will be "immobile in soil," and therefore the chemical will not contaminate groundwater. EPA acknowledges that the material does have the potential to contaminate surface waters. If glyphosate reaches surface water, it is not broken down readily by water or sunlight.²⁰ The half-life of glyphosate in pond water ranges from 70 to 84 days.²¹

Glyphosate is moderately persistent in soil, with an average half-life of 47 days, although there are studies reporting field half lives of up to 174 days.²² Residues of glyphosate have been known to persist for months in anaerobic soils deficient in microorganisms. Glyphosate residues are difficult to detect in environmental samples and most laboratories are not able to perform this service because of the lack of generally available, economically feasible methodology.

Effects on Nontarget Animals

Glyphosate use directly impacts a variety of nontarget animals including insects, earthworms, and fish, and indirectly impacts birds and small mammals.²³ A study conducted by the International Organization for Biological Control found that exposure to Roundup™ killed over 50 percent of three species of beneficial insects – a parasitoid wasp, a lacewing and a ladybug.²⁴ Repeated applications of glyphosate significantly affected the growth and survival of earthworms.²⁵ Studies have also shown that glyphosate, and in particular the inert ingredients in the formulation of Roundup™ are acutely toxic to fish.²⁶

A 2005 University of Pittsburgh study finds finds that Roundup alone is "extremely lethal" to amphibians in concentrations found in the environment.²⁷

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Glyphosate *chemicalWATCH* Factsheet Bibliography

- ¹ US EPA 2000–2001 Pesticide Market Estimates Agriculture, Home and Garden
- ² National Agriculture Statistics Service (2005) in Acreage eds. Johanns, M. & Wiyatt, S. D. 6 30, (U.S. Dept. of Agriculture, Washington, DC).
- ³ Environmental Protection Agency. 1999. *Pesticides Industry Sales and Usage: 1996 and 1997 Market Estimates*. EPA-733-R-99-001. p. 21, Table 8. <<http://www.epa.gov/opphead1/pestsales/97pestsales/97pestsales.pdf>>
- ⁴ Ibid. p. 22, Table 9.
- ⁵ Northwest Coalition for Alternatives to Pesticides. 1998. *Herbicide Factsheet: Glyphosate (Roundup)*. Journal of Pesticide Reform, vol. 18, no. 3, p. 4.
- ⁶ Environmental Protection Agency. 1993. *Glyphosate Reregistration Eligibility Decision*. p. viii. <http://www.epa.gov/REDS/old_reds/glyphosate.pdf>
- ⁷ Ibid.
- ⁸ Pesticide Action Network, 1997. Glyphosate fact sheet. For more information about glyphosate visit <<http://data.pesticideinfo.org/4DAction/GetRecord/PC33138>>
- ⁹ Benachour, Nora and Gilles-Eric Seralini. 2009. "Glyphosate Formulations Induce Apoptosis and Necrosis in Human Umbilical, Embryonic, and Placental Cells." *Chem. Res. Toxicol.* 22 (1), pp 97–105.
- ¹⁰ NCAP. 1998. p. 5.
- ¹¹ EPA. 1993.
- ¹² Calvert, G. et al. 2008. "Acute Pesticide Poisoning Among Agricultural Workers in the United States, 1998–2005." *American Journal of Industrial Medicine*. 51:883–898.
- ¹³ California Pesticide Illness Surveillance Program Report – 1998. Table 4. <<http://www.cdpr.ca.gov/docs/dprdocs/pisp/1998pisp.htm>>
- ¹⁴ NCAP. 1998. p. 5, Table 1.
- ¹⁵ EPA. 1993.
- ¹⁶ Ibid.
- ¹⁷ NCAP. 1998. Citing EPA OPPTS, 1991, Second Peer Review of Glyphosate. Memo from W. Dykstra and G.Z. Ghali, HED to R. Taylor, Registration Division and L. Rossi, Special Review and Reregistration Division.
- ¹⁸ Hietanen, E., et al. 1983. "Effects of phenoxy herbicides and glyphosate on the hepatic and intestinal biotransformation activities in the rat." *Acta Pharm et Toxicol* 53:103-112.
- ¹⁹ Porter, W. 2004. "Do Pesticides Affect Learning and Behavior? The neuro-endocrine-immune connection." *Pesticides and You*. 24 (1):11-15.
- ²⁰ EPA. 1993
- ²¹ Extension Toxicology Network. 1996. Pesticide Information Profiles: Glyphosate. <<http://ace.orst.edu/cgi-bin/mfs/01/pips/glyphosa.htm>>
- ²² Ibid.
- ²³ NCAP. 1998. pps. 11-13.
- ²⁴ Ibid. p. 11. Citing: Hassan, S.A. et al. 1988. Results of the fourth joint pesticide testing programme carried out by the IOBC/WPRS-Working Group "Pesticides and Beneficial Organisms." *J. Appl. Ent.* 105: 321-329.
- ²⁵ Ibid. Citing: Springett, J.A. and R.A.J. Gray. 1992. Effect of repeated low doses of biocides on the earthworm *Aporrectodea caliginosa* in laboratory culture. *Soil Biol. Biochem.* 24(12): 1739-1744.
- ²⁶ Ibid. p. 12. Citing: Folmar, L.C., H.O. Sanders, and A.M. Julin. 1979. Toxicity of the herbicide glyphosate and several of its formulations to fish and aquatic invertebrates. *Arch. Environ. Contam. Toxicol.* 8: 269-278.
- ²⁷ Relyea, Rick. 2005. "THE LETHAL IMPACT OF ROUNDUP ON AQUATIC AND TERRESTRIAL AMPHIBIANS." *Ecological Applications*, 15(4), 1118–1124.

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