



# Glyphosate (Roundup)

## SUMMARY

Despite the prevalent myth that this widely-used herbicide is harmless, glyphosate (N-phosphono-methyl glycine) is associated with a wide range of illnesses, including non-Hodgkin's lymphoma (NHL), genetic damage, liver and kidney damage, endocrine disruption, as well as environmental damage, including water contamination and harm to amphibians. Researchers have also determined that the "inert" ingredients in glyphosate products, especially polyethoxylated tallow amine or POEA—a surfactant commonly used in glyphosate and other herbicidal products—are even more toxic than glyphosate itself. Monsanto, manufacturer of glyphosate, formulates many products such as Roundup™ and Rodeo™ and markets formulations exclusively used on genetically engineered (GE) crops. Glyphosate is one of the most widely used herbicides in the world, due in large part to the increased cultivation of GE crops that are tolerant of the herbicide.

## GENERAL

First registered for use in 1974, glyphosate is used to kill a variety of broadleaf weeds and grasses. Labeled uses of glyphosate account for approximately 276 million pounds applied in 2014 on over 100 terrestrial food crops, as well as other non-food sites, including forestry, greenhouses, rights-of-way, turf, garden beds, and hardscapes.<sup>1</sup>

The greatest overall glyphosate use by acreage is in the Mississippi River basin where most applications are for weed control on GE corn, soybeans, and

## ChemicalWATCH Summary Stats

**CAS Registry Number:** 1071-83-6

**Trade Name:** Roundup, Rodeo

**Use:** Nonselective herbicide for broadleaf weed and grass control on food and non-food field crop sites.

**Toxicity rating:** Toxic

**Signal Words:** Caution

**Health Effects:** Eye and skin irritation, associated with non-Hodgkin's Lymphoma, and spontaneous abortions. Other ingredients in formulated products are linked to developmental abnormalities, decreased sperm count, abnormal sperm, and cell death of embryonic, placental and umbilical cord cells. Functions as an antibiotic.

**Environmental Effects:** Weed resistance due to use in genetically engineered crop production, water contamination, soil quality degradation, toxic to soil microorganisms and aquatic organisms. A source of phosphate pollution in water.

cotton, as well as other crops. Contrary to industry claims that GE crops would result in lower pesticide use rates, glyphosate use in agriculture rose 300-fold from 1974 to 2014, with non-agricultural uses increasing by 43-fold during the same time.<sup>2</sup>

Plants treated with glyphosate translocate the systemic herbicide to their roots, growing points, and fruit, where it blocks the activity of the enzyme 5-enolpyruvylshikimate-3-phosphate synthase (EPSPS), a key enzyme in the shikimate pathway of aromatic amino acid production, ultimately leading to the plant's death by starvation.<sup>3</sup> Because plants absorb glyphosate, it cannot be completely removed by washing or other food preparation.

It persists in food products for up to two years.<sup>4</sup>

## GLYPHOSATE FORMULATED PRODUCTS AND OTHER INGREDIENTS

Glyphosate products (Roundup) are more toxic than glyphosate alone, resulting in a number of chronic, developmental, and endocrine-disrupting impacts.<sup>5,6,7,8,9,10</sup> The "inert" ingredients in Roundup formulations kill human cells at very low concentrations.<sup>11</sup> At least some glyphosate-based products are genotoxic.<sup>12</sup> One "inert," polyethoxylated tallow amine (POEA), is extremely toxic to aquatic organisms.<sup>13,14</sup> It accounts for more than 86% of Roundup toxicity observed in microalgae and crustaceans.<sup>15</sup>

## ACUTE EXPOSURE TO GLYPHOSATE

Although EPA considers glyphosate to be “of relatively low oral and dermal acute toxicity,”<sup>16</sup> 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.<sup>17</sup> In developmental toxicity studies using pregnant rats and rabbits, effects of glyphosate in high dose groups include diarrhea, decreased body weight gain, nasal discharge and death.<sup>18</sup>

## CHRONIC EXPOSURE TO GLYPHOSATE

Since EPA’s classification of glyphosate as a Group E carcinogen—or “evidence of non-carcinogenicity for humans,” the International Agency for Research on Cancer (IARC) in 2015 classified glyphosate as a Group 2A “probable” carcinogen, which means that the chemical is probably carcinogenic to humans based on sufficient evidence of carcinogenicity in experimental animals.<sup>19</sup> As of July 7, 2017, glyphosate is listed as a cancer-causing chemical under California’s Safe Drinking Water and Toxic Enforcement Act of 1986 (Proposition 65). This requires cancer warning labels be placed on end-use glyphosate products in California.<sup>20</sup> It has been specifically linked to non-Hodgkin’s Lymphoma (NHL),<sup>21,22,23</sup> and multiple myeloma.<sup>24</sup>

Glyphosate causes DNA and chromosomal damage in human cells.<sup>25</sup> Glyphosate and its formulated products adversely affect embryonic, placental and umbilical cord cells, affect fetal development, and increase the risk for spontaneous abortions.<sup>26</sup> Detectable concentrations of glyphosate have been found in the urine of farm children.<sup>27</sup> Chronic, ultra-low dose exposure to glyphosate in drinking water results in adverse impacts on the health of liver and kidneys.<sup>28</sup> Glyphosate is considered to be an endocrine disruptor.<sup>29</sup> It can cause changes to DNA function resulting in the onset of chronic disease.<sup>30</sup>

## GLYPHOSATE IS AN ANTIBIOTIC

Glyphosate works by disrupting a crucial pathway for manufacturing aromatic amino acids in plants—but not animals—and, therefore, many have assumed that it does not harm humans. However, many bacteria use the shikimate pathway, and glyphosate has been patented as an antibiotic.<sup>31</sup> The destruction of bacteria in the human gut is a major contributor to disease, and the destruction of soil microbiota leads to unhealthy agricultural systems with an increasing dependence on agricultural chemicals.<sup>32</sup> Disturbing the microbiota can contribute to a whole host of “21st century diseases,” including diabetes, obesity, food allergies, heart disease, antibiotic-resistant infections, cancer, asthma, autism, irritable bowel syndrome, multiple sclerosis, rheumatoid arthritis, celiac disease, inflammatory bowel disease, and more. The rise in these same diseases is tightly correlated with the use of the herbicide glyphosate, and glyphosate exposure can result in the inflammation that is at the root of these diseases.<sup>33</sup> Glyphosate appears to have more negative impacts on beneficial bacteria, allowing pathogens to flourish.<sup>34,35</sup>

## ANTIBIOTIC RESISTANCE

Bacteria resistant to the most commonly prescribed antibiotics result in longer-lasting infections, higher medical expenses, the need for more expensive or hazardous medications, and the inability to treat life-threatening infections. The development and spread of antibiotic resistance is the inevitable effect of the use of antibiotics.<sup>36,37</sup> Use of antibiotics like glyphosate in agriculture allows residues of antibiotics and antibiotic-resistant bacteria on agricultural lands to move through the environment, contaminate waterways, and ultimately reach consumers in food.<sup>38</sup> Both the human gut and contaminated waterways provide incubators for antibiotic resistance.

## ENVIRONMENTAL FATE

Glyphosate has the potential to contaminate surface waters and is not broken down readily by water or sunlight in

surface water,<sup>39</sup> with a half-life of 70 to 84 days.<sup>40</sup> U.S. Geological Survey (USGS) surveys detect glyphosate and its degradate aminomethylphosphonic acid (AMPA) in the majority of samples,<sup>41</sup> persisting from spring through to fall.<sup>42</sup> Glyphosate and/or AMPA have also been detected in significant levels in rain in agricultural areas across the Mississippi River watershed, in more than 50 percent of soil and sediment samples, in water samples from ditches and drains, and in more than 80 percent of wastewater treatment plant samples.<sup>43</sup> Glyphosate also contributes to phosphorous pollution of waterbodies.

Residues of glyphosate may persist for months in anaerobic soils deficient in microorganisms. Heavy use of Roundup on GE crops appears to cause harmful changes in soil, potentially hindering yields of crops.<sup>44</sup> Concerns for soil health from long-term glyphosate use include reduction of nutrient availability for plants and organisms; disruption of organism diversity, especially in the areas around plant roots; reductions of beneficial soil bacteria; increases in plant root pathogens; disturbed earthworm activity; reduced bacterial nitrogen fixation; and compromised growth and reproduction in some soil and aquatic organisms.<sup>45,46</sup>

## 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.<sup>47</sup> Roundup kills beneficial insects, including parasitoid wasps, lacewings and ladybugs.<sup>48</sup> Repeated applications of glyphosate significantly affect the growth and survival of earthworms.<sup>49</sup> Environmental factors, such as high sedimentation, increases in temperature and pH levels increase the toxicity of Roundup, especially to young fish.<sup>50</sup>

Roundup, in sublethal and environmentally relevant concentrations, causes morphological changes in two species of amphibians by interfering with hormones.<sup>51</sup> It is “extremely lethal” to amphibians in concentrations found in the environment.<sup>52,53,54</sup>

## FOOD RESIDUES

Sampling by the U.S. Food and Drug Administration), under pressure after the release of the IARC report, found residues of glyphosate in honey and oats.<sup>55</sup> Residues, which have no established legal allowance in honey, were found in all samples and in some cases at double the allowable limit set in the European Union. FDA also found residues in oat products, including cereals for babies. These tests follow European findings of glyphosate residues in German beer and British bread, in addition to private testing in the U.S. in Cheerios, cookies, crackers, and wine.<sup>56,57, 58, 59, 60, 61</sup>

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