



NORTHWEST CENTER FOR  
ALTERNATIVES TO PESTICIDES

# What To Know About Glyphosate & Alternative Weed Management

**When it comes to lawn and garden maintenance**, most of us aren't strangers to unwanted weeds and the products available for easy and fast eradication in the pursuit of a pristine landscape.

Many controversial products have taken center stage as the debate between conscientious consumers and for-profit corporations demands our attention to get the facts straight. At the helm, the commonly used glyphosate-based herbicide weed killer, Roundup, has sparked the controversy around alleged connections to carcinogenic properties in home-use applicants, school grounds keepers and conventional use in the agriculture sector.<sup>1</sup>

Understanding the scientific analysis, risks, policy solutions, and alternatives will help us all better comprehend the concerns around chemical toxics in our environment and how to reduce their use and exposure.



**King County**

Department of  
Natural Resources and Parks  
**Wastewater Treatment Division**

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# Understanding Glyphosate

## Know the Basics

**G**lyphosate is a broad-spectrum herbicide that targets broadleaf weeds, grasses and woody plants by disrupting a crucial pathway for manufacturing aromatic amino acids in plants and insects but not animals.<sup>2</sup> Studies have reported that these compounds have been found to be toxic to humans and are increasing the risk of some cancers by more than 40 percent.<sup>3</sup>

The pesticide industry has claimed glyphosate does not cause harm to humans, but this is being challenged by new research and ongoing legal cases. Roughly 270 to 290 million pounds of glyphosate are used annually in the U.S., on over 100 crops and non-agricultural sites.<sup>4</sup>

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**A recent meta-analysis of the highest risk populations found that the risk of developing Non-Hodgkin's Lymphoma is increased by more than 40 percent when exposed to glyphosate.<sup>3</sup>**

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From 2001 to 2012, glyphosate was the most used conventional pesticide in the United States' agricultural sector and in the industrial/commercial/governmental sector, and the second-most used (after 2,4-D) in home and garden applications.<sup>4</sup> From the late 1970s to 2016,

there was a 100-fold increase in the frequency and volume of application of glyphosate-based herbicides (GBHs) worldwide, with further increases expected in the future, partly in response to the global emergence and spread of glyphosate-resistant weeds,<sup>5</sup> requiring greater application to maintain effectiveness. The development of glyphosate resistance in weed species is emerging as a costly problem.

While glyphosate products have been approved by regulatory bodies worldwide, concerns about their effects on humans and the environment persist, and have grown as the global usage of glyphosate increases.



Photo: Mike Mozart

# What recent studies tell us about glyphosate

New studies confirm a link between exposure to glyphosate and an increased risk of certain cancers. The World Health Organization's (WHO) working group has reclassified glyphosate as "probably carcinogenic to humans" (Group 2A), yet not all organizations and governments are in agreement with this decision.<sup>6</sup> The EPA reportedly reviewed epidemiological studies and felt it does not warrant any change in its cancer classification for glyphosate.<sup>7</sup> However, the state of California has classified glyphosate as a carcinogen.<sup>7</sup> Forty countries have banned or restricted glyphosate use, including Canada and Mexico.<sup>8</sup>

According to Henderson et al.,<sup>2</sup> pure glyphosate is low in toxicity, but products usually contain other ingredients that help the glyphosate get into the plants. The other ingredients in the mixture can make the product more toxic. Products containing glyphosate may cause eye or skin irritation. People who breathed in spray mist from products containing glyphosate felt irritation in their nose and throat. Swallowing products with glyphosate can cause increased saliva, burns in the mouth and throat, nausea, vomiting, and diarrhea. Fatalities have been reported in cases of intentional ingestion.<sup>2</sup>

Since the 2015 listing of glyphosate as a probable carcinogen by the WHO, there have been high profile court cases related to glyphosate and cancer that will likely protect others from pesticide exposure. This has exposed a weakness and biased collaboration between the EPA and the multi-billion dollar company, Monsanto.<sup>9</sup>

Glyphosate has also been linked to shorter gestational periods in pregnant women,<sup>10</sup> and chronic, ultra-low dose exposure to glyphosate in drinking water has been linked to adverse impacts on the health of the liver and kidneys.<sup>11</sup> The chemical is also linked to endocrine disruption and other human health concerns.<sup>12</sup> Glyphosate appears to have more negative impacts on beneficial bacteria, allowing pathogens to flourish. This can be seen with the destruction of soil microbiota which leads to unhealthy systems. The destruction of bacteria in the human gut can potentially be a major contributor to a host of modern diseases including diabetes, obesity, food allergies, and heart disease.<sup>13</sup> Research has also shown that glyphosate can have the same negative impact on bee gut health.<sup>14</sup>

Glyphosate's presence in surface waters is widespread. U.S. Geological Survey (USGS) reports find glyphosate contamination when many presumed it would have already degraded. Glyphosate and AMPA (a metabolite) are more frequently detected in surface water rather than groundwater.<sup>15</sup> It is also detected in more than 50 percent of soil and sediment samples, as well as in water samples from ditches and drains. Glyphosate has been found in 75% of rain samples.<sup>16</sup>

Pets may be at risk if they touch or eat plants that are still wet with spray from products containing glyphosate. Animals exposed to products with glyphosate may drool, vomit, have diarrhea, lose their appetite, or seem sleepy.<sup>2</sup>

## Time for Policy Change



*NCAP's Megan Dunn (far right) testifies against drift spray*

Many agencies, homeowners, municipalities, and pesticide applicators have decided to take a precautionary approach when considering the use of a pesticide. The Northwest Center for Alternatives to Pesticides (NCAP) encourages ecologically sound best practices and long-term policies that include restrictions designed to adapt if the chemical listing is adjusted based on new research. For example, the Oregon IPM in Schools law includes a low-impact pesticide list. Any pesticides that are classified as a human carcinogen or probable/likely to be a human carcinogen under EPA guidelines would not be allowed in schools.

Source: ORS 634.700-634.750, see <https://www.oregon.gov/ODA/shared/Documents/Publications/PesticidesPARC/IPMInSchoolsFaqs.pdf>





# Alternative Weed Management

**W**hile we don't fully understand the potency of glyphosate, studies indicate individuals exposed to the highest doses are at the greatest risk and children are more susceptible to exposure.<sup>17</sup> A ban on one single chemical may lead schools, parks or cities to depend on a more harmful substitution, therefore we encourage solutions that focus on preventing the use of pesticides and ending the reliance on a cycle of harmful synthetic chemical pesticides.

Integrated Pest Management (IPM) methods focus on prevention and employing cultural and mechanical controls before turning to less toxic and certified organic herbicides. IPM provides successful weed management, often without the use of any synthetic pesticides. IPM best practices include weed mapping, cultural and mechanical controls, mulching, microbials, steaming, flame weeding, solarization, allelopathy, and least-toxic herbicides.<sup>18,19</sup>

Weeds can be a sign of overly dry or wet conditions, poor soil health, soil compaction (one of the most important factors that can affect soil health),

or a need for nutrients. Weed mapping and weed signatures can be used to track conditions and make changes accordingly, such as adding nutrients or planting nitrogen-fixing plants to improve soil health or drainage.<sup>20</sup>

It is also important to consider how much of a weed presence you are willing to tolerate. Some weeds can actually be beneficial by helping the soil through root aeration or adding nitrogen. Decide on a level of weed tolerance (for example 10% or 20%), then monitor conditions by mapping the weeds, by species, in your lawn or garden.<sup>20</sup>

Preventing contamination from weed seeds is another critical tool. Ensure that your garden, grass seeds and new plants are not contaminated with weed seeds and come from reliable sources. Use best practices to discourage lawn weeds, including proper tool cleaning, proper watering and fertilizing with slow release or organic fertilizer, proper grass mowing and aeration of soil to allow for soil, air and nutrients to reach roots.<sup>21</sup>



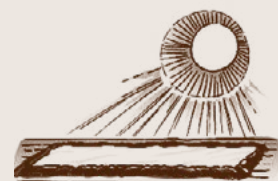
## Physical Removal

Physical removal is a good strategy for annual weeds before they go to seed. On some young perennials, vegetative parts must be removed.<sup>20</sup>



## Flame Weeding

Flame weeding consists of using heat to burst plant cells, causing loss of fluids and thermal denaturation of proteins and DNA. This process disrupts the photosynthetic apparatus causing plants to die.<sup>20</sup>



## Solarization

Solarization involves heating the soil by covering it with clear plastic tarp for 4 to 6 weeks,<sup>22</sup> trapping the sun's radiant energy and killing soil-born weeds and pests.

**M**ulches can be very successful for weed control. Mulch can be made from wood chips, straw, sawdust, rice hulls, shredded bark, etc. Four inches of material is usually sufficient to suppress growth. Mulch from organic material can be worked into the soil to provide nutrients at the end of the season.<sup>22</sup> Mulches can also be used as a border for mowing and can add aesthetic design for landscape beds, lawn borders and around trees.

Mulching techniques for weed control vary and include more common materials mentioned above, but may also include living mulches such as allelopathic plants and other weed suppressive crops, e.g. careful pairing and companion crops such as squash interplanted with corn to suppress weeds.<sup>23</sup>

In addition to biodegradable and living mulches, synthetic mulches such as polyethylene sheets, or polypropylene and polyester fabrics are often used for weed control. Plastic mulch that is dark in color is widely used to suppress weeds, though clear UV-stabilized 4 to 6 mil thick plastic is most effective when solarizing areas up to one acre.<sup>24</sup> In areas where irrigation is used, plastic landscape fabrics may be best as it allows water to more easily penetrate into the ground. Landscape fabric tends to last longer than polyethylene and is easier to use in ornamental plantings. Oftentimes a biodegradable mulch is applied on top of the landscape fabric to prevent sun damage and help control weeds.<sup>20</sup> Be prepared to manage some weeds in the top layer.

## Biodegradable Mulches



Photo: Tom Britt

Protective substances such as straw, sawdust, rice hulls, and shredded bark are best for prevention of annual or biennial weeds. Mulches can be worked into the soil to provide valuable organic material. The most effective areas to mulch are in between crops, borders and around tree bases acting as a buffer zone.<sup>20</sup>

## Synthetic Mulches



Photo: François Molle/IRD

UV-stabilized black or thin clear plastic can be effective for weed management. Ensure holes are fixed to prevent temperature loss and plant growth. Some biodegradable plastics are available that will break down over the course of one season. Incorporating more traditional biodegradable mulches on top of non-biodegradable fabrics may be a winning approach.

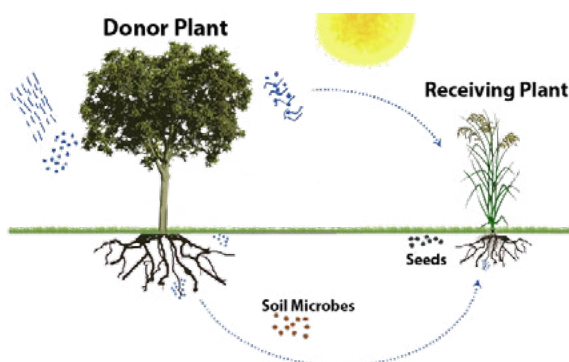
## Sheet Mulches



Top layer of organic mulch  
1-3" layer of compost  
1/4" lasagna paper/cardboard  
Layer of nitrogen rich material  
Soil amendments/cut grass  
Soil surface/roots

Sheet mulching may be used to prepare lawns or other areas for planting. It consists of paper or cardboard layered like a lasagna. Paper or cardboard which are rich in carbon should be alternated with layers of nitrogen rich materials like grass clippings, manure or composted waste. Soak the layers and add organic mulch to suppress weeds.<sup>25</sup>

## Allelopathic Mulches



Allelopathic mulches are a phenomenal interaction between receptor and donor plants. To ensure sustainable agricultural development, it is important to exploit cultivation systems that take advantage of the stimulatory/inhibitory influence of allelopathic plants to regulate plant growth and development and to avoid allelopathic autotoxicity.<sup>26</sup>



# Least-Toxic Herbicides

Photo: Nico Tranquilli

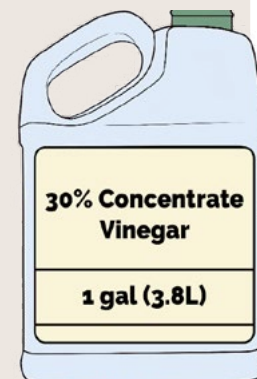
**Essential Oils** such as clove oil (eugenol) and orange oil (limonene) are toxic to plants when used in high concentrations.<sup>20</sup> Essential oils are volatile and leave very few residuals. However, the odor is potent and they should not be used if anyone is sensitive to oils or any active ingredients.<sup>27</sup> They work best on smaller weeds. Commercially made essential oils may be combined with vinegar and formulations can burn or irritate the skin and eyes, so always follow the label precautions.<sup>28</sup>

**Fatty Acids** act to kill weeds by desiccation or drying out,<sup>29</sup> and products are commercially available. One example is pelargonic acid which occurs naturally in foods and seeds, where it may act as a germination inhibitor. It is a known irritant, but is generally regarded as safe with a toxicity far below glyphosate. It should not be applied before precipitation and may be mildly hazardous to aquatic invertebrates. It is inert once degraded, degrades readily, and does not accumulate.<sup>30</sup>

**Herbicidal Soaps** are salts of fatty acids. They are most effective when used on annual weeds because they only kill exposed foliage; they are not as effective on perennials since they do not destroy roots for long-term impact. With repeated application, herbicidal soaps work by stopping photosynthesis and eventually cutting off the plant's food supply. Several companies sell these products, which can require multiple application treatments.<sup>20</sup>

**Iron-Based Herbicides** contain iron HEDTA as the active ingredient and have been used effectively to control broadleaf weeds in turf. Turf can handle very high levels of iron, while most broadleaf plants cannot.<sup>31</sup> It is not known to be toxic to mammals, birds, fish or honeybees but can impact amphibians, and it can accumulate.<sup>32</sup> Care needs to be taken to reduce discoloration of vegetation and hard surfaces.<sup>33</sup>

**Vinegar** (acetic acid) has a low environmental impact and can be used by homeowners and landscapers. Studies of acetic acid show it's effective at controlling weeds and indicate low potential for bioaccumulation, however, it can lower the pH level of the soil. Spot spraying with a more concentrated solution has shown to be effective. USDA studies show that water with 10, 15 or 20% acetic acid can kill at least 80% and upwards of 100% of annual weeds.<sup>33</sup> When using 30% acetic acid on broadleaf and narrow leaf weeds in greenhouse tests, effectiveness was nearly 100% at four weeks after treatment but not as effective for certain weeds such as crowfoot (*Ranunculaceae spp.*), sicklepod (*Senna obtusifolia*) and yellow nutsedge (*Cyperus esculentus*).<sup>34</sup> Vinegar from the grocery store contains only 5% acetic acid and works well only for very small weeds, less than 3-5 inches in height.<sup>35</sup> Substances such as concentrated vinegar are corrosive and must be handled with care.



**H**erbicides are either pre-emergent (prevent seeds from sprouting) or post-emergent (control existing weeds). The least toxic pre-emergent pesticide is corn gluten meal, but suppression varies based on the weed and application techniques.<sup>36,18</sup>

According to Quarles,<sup>20</sup> less potent or nontoxic post-emergent chemical controls kill by desiccation or oxidation. These include soaps, fatty acids, essential oils, or some mixture of these. These products will kill foliage but do not penetrate the root systems, so new growth can occur and treatment can require multiple applications after a few weeks. Effectiveness is better for broadleaf plants and improves with good coverage, warmer weather, higher humidity, product concentration and repeated applications.<sup>20</sup>

Although these low-toxicity herbicides do not have many of the issues associated with glyphosate or other synthetic biocides, it is important to be aware of their risks. Always read and fully understand product labels, and employ safety measures such as the use of personal protective equipment. Notably, acetic acid, known widely as horticultural

vinegar, can cause serious burns or critical equipment failure due to its corrosive properties.<sup>37</sup> Some applicators may also be sensitive to compounds in essential oils.<sup>27</sup>

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**The upfront expenses of less toxic herbicides may deter some people, because costs may be greater. However, the retail cost of glyphosate does not include costs to the environment such as disturbance of the balance of soil and plant ecology, still unknown risks to wildlife, and glyphosate's carcinogenic effects on humans.**

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The latest research, compounded by the increased risk associated to applicators and children, are compelling reasons for cities, parks, schools, and home gardeners to end the use of glyphosate and implement alternatives today.



Photo: USFWS



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