A farmer sprays herbicide on his corn crops in El Salvador.

Glyphosate: safe or sorry?

Despite is reputation for being a relatively innocuous herbicide, recent research indicates that glyphosate may pose long-term dangers. JO IMMIG reports.

IT IS PERHAPS A PUBLIC RELATIONS triumph that glyphosate, a non-selective herbicide designed to kill living plants, is so widely regarded as "safe". While bush regenerators maintain they couldn't do their work without it, emerging research may yet see glyphosate join the long list of pesticides that were once thought to be safe, but turn out to be harmful.

According to organic gardening expert Lyn Bagnall, "Some organic gardeners think that [glyphosate] has some sort of exemption from being labelled as a chemical". Bagnall is often asked about problem vegetable crops after people have sprayed glyphosate on the bed for weeds, and says, "I don't think they believe me when I tell them the problem is herbicide damage".

Farmers, bush regenerators and public authorities all use glyphosate, as do many home gardeners. People generally seem to believe it is harmless, biodegradable and disappears from the soil.

Glyphosate is sometimes referred to by the original trade name Roundup, which was first marketed by Monsanto in 1974, and the two names are often used interchangeably. Many companies now manufacture glyphosate products, as it is off patent. Australia has more than 300 such products registered for use, many for home gardens.

Monsanto's literature claims: "Glyphosate has an excellent human health and environmental profile, and a long history of safe use for over 30 years in 130 countries."

Perhaps it's because of this "safe" reputation that it's common to see people spraying glyphosate without using protective equipment – and often with other people in the vicinity, despite warnings on product labels not to come into contact with the chemical. While regulators agree glyphosate has a relatively low acute (short-term) toxicity compared with other herbicides, recent research indicating possible long-term health effects and environmental impacts is causing controversy.

In spite of this, the Australian Pesticides and Veterinary Medicines Authority (APVMA) advised *OG* that it "... has not received or is aware of any new research that suggests that the current regulatory setting for glyphosate needs to be revised".

Persistence in the soil

Glyphosate is relatively persistent in soil, especially in cold climates, where residues have been found up to three years after use. In warmer climates it stays in the soil for between four and 180 days. Monsanto states the average half-life of glyphosate in soil is 40 days. Although it does bind to soil particles (which is perhaps why claims

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are made that it becomes inactive or "disappears" when it contacts soil), there is evidence that it can become unbound from soil, where it is then free to move into plants and leach out.

"It can appear in vegetable crops planted after the previous vegetation has been sprayed with glyphosate," says Australian organic advisor Dave Forrest. Agricultural soils high in phosphates from fertilisers can also have higher levels of unbound glyphosate.

Glyphosate residue in soil alters the microbial balance. Some soil experts say the effect is like a "bacterial bloom" that causes an imbalance between bacteria and fungi, creating conditions that ultimately favour more weed growth. Continual application of glyphosate has been found to reduce nitrogen fixation, damage beneficial fungi and make micronutrients less available, ultimately leading to plant diseases.

Despite this, the Victorian No-Till Farmers Association told *OG* that, "No-till farmers believe the effect of herbicides to soil health initially is far outweighed by the benefits of not cultivating the soil".

Safety questioned

Last year, France's Supreme Court upheld earlier decisions by two courts that Monsanto had not told the truth about the safety of Roundup. The court confirmed that Monsanto had falsely advertised its herbicide as being "biodegradable" and claimed that it "left the soil clean".[1]

Many people are not aware that glyphosate is soluble and persistent in water, where its half-life can be up to five months. It can actually be found in pond sediments for up to a year. Its residues affect the entire food chain including microorganisms, plankton, algae, molluscs and frogs, leading to an imbalance in the natural order, which causes algal blooms.

In 2003 glyphosate use was restricted in Denmark after it was found to be contaminating ground water – the country's main source of drinking water – at five times the acceptable limit.

The Denmark and Greenland Geological Research Institute found that glyphosate had sieved down through the soil without being broken down by bacteria before it reached the groundwater.[2]

In a move supported by key Canadian health authorities, more than 100 Canadian municipalities have passed bylaws restricting the use of all pesticides (including glyphosate) for cosmetic purposes such as lawns and driveways, because of health concerns about pesticide exposure.[3]

Sowing GM soya beans on a farm in southern Brazil.

Cell death

The Pesticide Action Network Asia Pacific (PANAP) last year released an extensive report collating published scientific research on a range of health and environmental problems relating to glyphosate. These include: links to cancer, in particular non-Hodgkin's lymphoma, endocrine (hormone) disruption, genetic damage, and reproductive and developmental effects (see www.panap.net for more details).

Studies by Professor Gilles-Eric Seralini and a team at Caen University in France found that exposing human cells to glyphosate damaged and killed them. In its latest research (2009), the Caen team found that four glyphosate-based herbicides in Roundup formulations caused human umbilical, embryonic and placental cells to die within 24 hours of exposure to concentrations that correspond to low-level residues often found in food and feed. [4]

HOW GLYPHOSATE WORKS

There are several different forms of glyphosate, but the majority of commercial products contain it as isopropylamine salt.

When a glyphosate product is sprayed on a plant, it is absorbed through the foliage (assisted by surfactants, or wetting agents, in the formulation), and moves within the plant to the shoot apex, rhizomes and roots, where it is then quickly released into the soil surrounding the roots.

Glyphosate kills the plant by blocking the activity of an enzyme that is essential for it to make amino acids. Without these amino acids, the plant can't make proteins needed for life and it dies over a number of days. Glyphosate kills the whole plant above and below ground, which "can contribute to erosion problems" says Australian organic advisor David Forrest.

A 2005 study found glyphosate was toxic to human placental cells within 18 hours of exposure to concentrations lower than those found with agricultural use, and the effect increased in the presence of Roundup adjuvants – substances that are added to improve the herbicide's performance (see 'Hidden toxins', below)[5]. Monsanto dismissed the findings, saying they "have no relevance to a living animal and provide no information about real-world risks to humans".

Trouble in Argentina

In Argentina, where an estimated 200 million litres of glyphosate is used in soybean production each year (mostly for GE Roundup-resistant varieties), the Supreme Court ordered a ban on crop spraying within 1km of residential areas in some provinces to reduce community exposure to spray drift. [6]

The legal action was initiated by the Environmental Lawyers Association, on behalf of affected communities that called for a total ban on glyphosate spraying because of health concerns. Their fears were heightened by findings of independent research conducted by Professor Andres Carrasco, an embryologist at the University of Buenos Aires. He found that glyphosate could be harmful to human health because it caused developmental effects in amphibian embryos such as eye defects, deformed cartilage and under-developed kidneys, at low concentrations.[7]

Hidden toxins

Glyphosate formulations contain so-called "inert" ingredients, known as adjuvants. Because they are considered "inert", these are not assessed or disclosed on the product label or in Material Safety Data Sheets (MSDS). The law protects this information as "confidential", at the expense of the community's right to know all the ingredients.

The problem is, some of these adjuvants have turned out to be more toxic than glyphosate itself. In 1996, the then National Registration Authority (now APVMA), carried out a review of glyphosate products triggered by environmental concerns relating to the surfactant in some formulations (a surfactant increases the penetration of the glyphosate into the leaf cuticle).

Researchers in Western Australia found glyphosate products were acutely toxic to tadpoles and frogs at levels likely to be encountered in the environment. The APVMA reviewed 75 products and found the toxicity of the surfactants in all the formulations "was undesirably high for aquatic environments". They required label changes to include a warning statement precluding use on or adjacent to waterways.

One study reviewed said the surfactant was: "...clearly the dominant contributor to the toxicity of Roundup and similar glyphosate formulations".[8]

Weed resistance

According to the APVMA, one issue on the regulatory horizon is weed resistance to glyphosate. Worldwide there are now 16 weeds with confirmed resistance. Some are attributing the problem to the introduction of glyphosate-resistant GE crops, and increased use of glyphosate in isolation from other weed management tools.

A new mechanism of resistance called "gene amplification" was also recently reported, with the study authors concluding that it "could threaten the sustainable use of glyphosate-resistant crop technology".[9] No-till farming, with its high use of herbicides, as well as chemical fallow, is also believed to be contributing to resistance pressure.

The organic alternative

The use of glyphosate, or any other synthetic herbicides, is not permitted under organic certification standards.

Organic weed control focuses on soil health and management techniques rather than the use of chemical products. Techniques permitted include grazing, mulching and slashing, flame and steam weeding, biological controls and mechanical cultivation. Steam weeders are commercially available for use on both farms and urban environments (see Products, page 22, for details of one brand). Some councils are using steam weed control to reduce risks to the community and the environment from herbicides. Home-made and commercial, low-toxicity, organic herbicides are other options to consider, and at least one organic herbicide is in the pipeline. OG

References

1. *BBC News*: Monsanto guilty in 'false ad' row (15/10/09), news.bbc.co.uk/2/hi/8308903.stm

2. *Organic News* organic.com.au/news/2003.09.15/

3. K.L. Bassil *et al*, Cancer health effects of pesticides, *Canadian Family Physician*, Vol. 53, No.10 (2007)

4. Nora Benachour et al, Glyphosate Formulations Induce Apoptosis and Necrosis in Human Umbilical, Embryonic and Placental Cells, *Chemical Research in Toxicology* (2009), www.pubs.acs.org/doi/abs/10.1021/tx800218n

5. S. Richard *et al* (2005), Differential effects of glyphosate and Roundup on human placental cells and aromatase, *Environmental Health Perspectives*, 113 (10).

6. Nicolas Misculin, Argentine Herbicide Lawsuit Alarms Soy Farmers, Reuters (2009), www.reuters.com/article/idUSN07337708

7. Marie Trigona, Study Released in Argentina Puts Glyphosate Under Fire, Americas Program, Centre for International Policy (2009).

8. APVMA *Glyphosate Chemical Review*, www.apvma.gov.au

9. T.A Gaines et al (2010), Gene amplification confers glyphosate resistance in *Amaranthus palmeri*, www.pnas.org/cgi/doi/10.1073/pnas.0906649107