

Observations on Herbicide Choices & Amphibian Conservation

With our increasing awareness of the threats posed by invasive exotic plant introductions, it is often necessary for today's land managers and owners to employ herbicides to achieve their management objectives.

Glyphosate is a non-selective systemic herbicide widely used for vegetation control. It is considered relatively non-toxic to humans and most terrestrial wildlife and as such has been marketed for years as environmentally-friendly. The chemical kills plants by inhibiting the activity of certain enzymes that are present only in plants.

Glyphosate is the active ingredient in Roundup, which was manufactured exclusively by Monsanto until 2000, when the patent expired. Since then many other companies have developed their own glyphosate formulations. Most of the glyphosate products marketed for today contain surfactants, which are added to enhance the effectiveness of the herbicide by increasing foliar penetration.

Before an herbicide can be registered for use in the United States, the manufacturer has to conduct toxicity studies on a variety of living organisms. Monsanto reported that aquatic species were much more sensitive to the formulated product than to the technical grade glyphosate that was used to make Roundup. The higher toxicity of the formulations was determined to be due to the presence of POEA (polyethoxylated tallow amine) surfactants.

As a precaution to prevent harm to aquatic life, Roundup and many other surfactant-loaded glyphosate formulations are not labeled for aquatic use. When these formulations are applied to upland sites according to label instructions, the risk to surfactant-sensitive species is considered low. While this may be the case for fish it does not necessarily apply to amphibians.

Recent studies have suggested that in addition to having negative effects on tadpoles within an impacted aquatic environment, surfactant-loaded formulations such as Roundup can also cause substantial mortality in juvenile terrestrial frogs and toads. Many frogs, toads, and salamanders that breed in water also routinely use non-aquatic areas and could easily be exposed to glyphosate formulations that contain harmful surfactants through direct application and not just incidental drift.

For those of us concerned with amphibian conservation issues, this scenario may be viewed as an unacceptable risk to a group of animals already in decline. This then begs the question – can we use a glyphosate herbicide to control invasive plants without undue risk to amphibians that are found in terrestrial situations?

The answer is yes, because fortunately there are surfactant-free glyphosate products available. Some examples of surfactant-free 53.8% glyphosate products are Accord Concentrate (Dow Agrosiences), Foresters Non Selective (Nufarm),

Aquamaster (Monsanto), AquaNeat (Nufarm), and Rodeo (Dow Agrosiences). These will either be labeled specifically as an aquatic herbicide or the label will indicate that it can be used for forestry, rights-of-ways, and habitat restoration sites that include wetlands.

All herbicides come with a specimen label. It is attached to the container itself but is also available from the internet.

<http://www.cdms.net/LabelsMsds/LMDefault.aspx?ms=1,2,3,4>

The trade name of the product, its intended use, and the active ingredients will be listed first, along with the signal word and the necessary precautions to take with the product. Adjuvants such as surfactants are usually included under Inert Ingredients on the label because they are not required to be disclosed. Unfortunately, this can make it quite difficult to tell whether a product actually contains a surfactant or not just by looking at the label. Another document called the Material Safety Data Sheet (MSDS) can often be a better source of information.

Toxicological and ecological information from various surfactant-free glyphosate products can be found in the MSDS provided by the manufacturer. Generally, surfactant-free 53.8% glyphosate products are in the range of >1000 mg/L (ppm) for bluegill and trout 96-hr LC50. Under U.S. Environmental Protection Agency (EPA) guidelines for aquatic toxicology tests, this falls into the practically nontoxic category. In comparison, Roundup 96-hr LC50 for bluegill and trout is less than 10 mg/L (ppm). The LC50 or 'lethal concentration, 50%' is the concentration of a substance calculated to kill 50% of the test animals.

Although the MSDS information provided by the chemical companies in the U.S. shows no values for frogs, it is logical to conclude that the surfactant-free glyphosate products would pose less risk to amphibians as well as fish and this has generally been the consensus drawn from various independent research studies conducted on frogs. These products allow for a fairly high safety margin for sensitive organisms exposed to glyphosate through normal application rates recommended on the label.

The surfactant-free 53.8% products do not seem to be as commonly available as the numerous glyphosate products formulated with surfactant that are marketed for lawn and garden use. Some aquatic glyphosate herbicides may be obtained locally from farm and garden stores or from local chemical warehouses that carry pesticides for agricultural and landscape use. The forestry herbicides will usually have to be ordered from companies that specialize in herbicides for invasive plant control.

<http://www.helenachemical.com/locations/Pages/locations.aspx>

<http://www.uap.com/uap/> (see Monroe NC location for forestry herbicides).

Prices for what is essentially the same product (53.8 % glyphosate, in the form of its isopropylamine salt) can vary significantly from one brand to another.

The use of the surfactant-free glyphosate can be very effective for 'cut stem' and 'hack and squirt' treatments on many species of woody plants. These methods use a targeted application of glyphosate on the trunk or stem of the plant to be controlled. It can be labor-intensive, especially over large areas, but the directed application reduces the risk of damage to non-target plants and the lack of surfactant minimizes the threat to sensitive wildlife as well.

To be effective as a foliar treatment, the surfactant-free 53.8% glyphosate labels recommend adding a surfactant. So the question arises - are there safer surfactants available than what is in Roundup?

The answer is yes, but it is a qualified yes.

You would think that if a surfactant is needed (for foliar applications) choosing one that is labeled for aquatic use would be a safe bet. Surprisingly, data supplied by the US Fish & Wildlife Service and other sources reveal that not all aquatic surfactants are equally benign. Over the past few years, while researching surfactants for use in invasive plant control, I have been dismayed to discover that many products that are apparently routinely used on invasives in natural areas (including riparian sites) have a toxicity rating that in some cases is no safer than Roundup.

For example, even though it was labeled for aquatic use, university researchers in Washington found that R-11 had a very low LC50 value for trout - less than Roundup Original which contains the POEA so deadly to aquatic animals (remember, the lower the value the greater the toxicity). It defeats the purpose to stipulate the use of an herbicide with a high LC50 value (like Rodeo) then add a surfactant with a low value (like R-11). The trouble is many land managers may not realize this is a problem.

Surfactants, oddly enough, do not fall under the same stringent testing and regulations as do herbicides. And because manufacturers can claim they are proprietary mixtures that need to be protected under the trade-secret laws, they do not have to publicly divulge the actual chemical makeup of their product. Currently, the EPA does not register or approve the labeling of spray adjuvants. As a result, toxicity data are not routinely available.

Some states do have spray adjuvant registration. For example, the Washington State Department of Agriculture (WSDA) requires aquatic toxicity tests if the product is labeled for aquatic use in that state. It is interesting to note that the R-11 label states the surfactant may be used with aquatically labeled products such as glyphosate but also cautions 'Not for aquatic use in Washington'.

Toxicity tests have identified one surfactant that fell into the range of >1000 mg/L (ppm) for bluegill and trout 96-hr LC50, the practically nontoxic category. Agri-Dex (Helena) allows for a greater safety margin than most if not all of the other surfactants that are marketed as aquatic-safe and is probably the least likely to cause harm to fish and aquatic organisms (including frogs).

So does it work? I have been using Agri-Dex with 53.8% glyphosate since 2005 and have found it very effective on all types of invasives. I use it in both upland and riparian sites because in addition to the frogs in my frog ponds, my woodland edges and openings have abundant amphibians – salamanders, toads, peepers, tree frogs, wood frogs – and selecting the least toxic chemical that will provide the desired result but afford a higher level of protection to sensitive species makes good ecological sense.

It is interesting to note that in Australia and the UK, a less toxic formulation of glyphosate with a surfactant included is available under the trade name Roundup Biactive. An Environmental Protection statement included on the MSDS reads 'ROUNDUP BIACTIVE has been formulated specifically to reduce the toxicity of the product to certain aquatic organisms including frogs and is the preferred ROUNDUP formulation for use around dams, waterways and other aquatic situations'. The 96-hr LC50 (Leopard frog tadpole) is >1040 mg/L (ppm). For reasons that are unclear, Roundup Biactive is not available in the US.

Until Roundup Biactive or a generic equivalent is available in this country, I contend that land managers concerned with the potential negative impacts of surfactant-loaded products on amphibians should be willing to take the few extra steps needed to ensure we are using the least toxic product currently available to us. In this case that means obtaining a surfactant-free 53.8% glyphosate product such as Accord Concentrate, Foresters Non Selective, Aquamaster, AquaNeat, Rodeo or a comparable herbicide and mixing it with the surfactant Agri-Dex.

Even with the arguments that surfactant toxicity is often rapidly diminished through natural processes such as interception by vegetation, soil binding, and dilution in water, and thus may have little direct lethal impacts on amphibians 'in the real world', we can't really rule out the possibility that they could be a contributing factor to population declines in ways we don't yet realize. We may never have definitive answers to the questions regarding the reasons amphibians are imperiled so why not do all we can to ensure our management activities do as little harm as possible to sensitive species.

Questions or comments, contact Kelly Hughes at hughesem@mindspring.com

Information Sources

USDA Forest Service. Glyphosate. Herbicide information profile, November 2000. USDA Forest Service, Pacific Northwest Region, Portland, OR.
<http://www.fs.fed.us/r6/weeds/Gly-Nov-17-2000.pdf>

Tu, M., Hurd, C., & J. M. Randall. 2001. Weed Control Methods Handbook, The Nature Conservancy.
<http://www.invasive.org/gist/handbook.html>

Howe, C. M., M. Berrill, B. D. Pauli, C. C. Helbring, K. Werry and N. Veldhoen. 2004. Toxicity of glyphosate-based pesticides to four North American frog species. Environmental Toxicology and Chemistry 23:1928–1938. Abstract

Relyea, R.A. 2005c. The lethal impact of Roundup on aquatic and terrestrial amphibians. Ecological Applications 15: 1118-1124.
<http://www.pitt.edu/~relyea/Site/Publications.html>

Diamond G; Durkin P. 1997. Effects of Surfactants on the Toxicity of Glyphosate, with Specific Reference to Rodeo. Prepared under USDA FS Contract No. 53-3187-5-12. Final Report. February 6, 1997.
<http://www.fs.fed.us/foresthealth/pesticide/pdfs/Surfactants.pdf>

Bakke, D. Analysis of issues surrounding the use of spray adjuvants with herbicides, December 2002. Revised January 2007. USDA Forest Service, Pacific Southwest Region, Vallejo, CA.
www.fs.fed.us/r5/spf/fhp/pesticide

U. S. Fish and Wildlife Service (USFWS). 2004? Acute toxicity of various nonionic surfactants / spreaders used with glyphosate products and toxicity of formulated glyphosate products. Internal report. Elaine Snyder-Conn. 5 pages.

Smith B.C., C.A. Curran, K.W. Brown, J.L. Cabarrus, J.B. Gown, J.K. McIntyre, E.E. Moreland, V.L. Wong, J.M. Grassley and C.E. Grue. 2004. Toxicity of four surfactants to juvenile rainbow trout: Implications for over-water use. Bulletin of Environmental Contamination and Toxicology 72 (3): 647-654. Abstract

Washington State Department of Agriculture, 2004. Memorandum: Summary of aquatic acute toxicity data for five spray adjuvants. From Erik W. Johansen, WSFA to Kyle Murphy, WSDA Statewide Spartina Program Coordinator, February 4, 2004.

Spray Adjuvant Registration in Washington
<http://agr.wa.gov/pestFert/Pesticides/docs/AdjuvRegGuide4335.pdf>

Technical Data Sheet AGDX080596. AGRI-DEX®.

<http://www.helenachemical-west.com/data/TDS/Agri.pdf>

National Registration Authority (NRA). 1996 Community Brief: Special Review of Glyphosate (June). National Registration Authority for Agricultural and Veterinary Chemicals. Australia.

<http://www.apvma.gov.au/chemrev/glyphosate.shtml>

Accessed 4-23-2008

Roundup Biactive Weedkiller Concentrate MSDS

http://www.scottsaustralia.com.au/images/MSDS/199410_435_430_475_470_Roundup_Biactive_Conc_1023_.pdf

Langeland, K. A. Safe Use of Glyphosate-containing Products in Aquatic and Upland Natural Areas, SS-AGR-104, February 2006. Agronomy Department, Center for Aquatic and Invasive Plants, Florida Cooperative Extension Service, Institute of food and Agricultural Sciences, University of Florida.

<http://edis.ifas.ufl.edu/AG248>

Bailey, M. A., J. N. Holmes, K. A. Buhlmann, and J. C. Mitchell 2006. Habitat Management Guidelines for Amphibians and Reptiles of the Southeastern United States. Partners in Amphibian and Reptile Conservation Technical publication HMG-2, Montgomery, Alabama.

Glyphosate Products Registered in North Carolina

http://www.kellysolutions.com/NC/showproductsbychem.asp?PC_Code=103601&PctStart=0&PctEnd=100&Chemical_Name=Isopropylamine+glyphosate+%28+N%2D%28phosphonomethyl%29glycine+%29

Chemical Producers & Distributors Association (CDMA) Voluntary Adjuvant Certification Program

<http://www.cpda.com/Adjuvant-Certification-Program>

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