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Tools / Chemicals

Roundup - Health Concerns

Good gardeners try to minimize the use of pesticides but one weed killer that has shown a good environmental record since it was introduced is Roundup.

Therefore it was troubling to read a newspaper headline that Roundup might harm frogs and other amphibians.

I am not a toxicologist but I though it would be good to show both sides of the situation together.

Please read everything below before making a judgement.

Roundup®highly lethal to amphibians, finds University of Pittsburgh researcher

PITTSBURGH--The herbicide Roundup® is widely used to eradicate weeds. But a study published today by a University of Pittsburgh researcher finds that the chemical may be eradicating much more than that.

Pitt assistant professor of biology Rick Relyea found that Roundup®, the second most commonly applied herbicide in the United States, is "extremely lethal" to amphibians. This field experiment is one of the most extensive studies on the effects of pesticides on nontarget organisms in a natural setting, and the results may provide a key link to global amphibian declines.

In a paper titled "The Impact of Insecticides and Herbicides on the Biodiversity and Productivity of Aquatic Communities," published in the journal Ecological Applications, Relyea examined how a pond's entire community--25 species, including crustaceans, insects, snails, and tadpoles--responded to the addition of the manufacturers' recommended doses of two insecticides--Sevin® (carbaryl) and malathion--and two herbicides--Roundup® (glyphosate) and 2,4-D.

Relyea found that Roundup® caused a 70 percent decline in amphibian biodiversity and an 86 percent decline in the total mass of tadpoles. Leopard frog tadpoles and gray tree frog tadpoles were completely eliminated and wood frog tadpoles and toad tadpoles were nearly eliminated. One species of frog, spring peepers, was unaffected.

"The most shocking insight coming out of this was that Roundup®, something designed to kill plants, was extremely lethal to amphibians," said Relyea, who conducted the research at Pitt's Pymatuning Laboratory of Ecology. "We added Roundup®, and the next day we looked in the tanks and there were dead tadpoles all over the bottom."

Relyea initially conducted the experiment to see whether the Roundup® would have an indirect effect on the frogs by killing their food source, the algae. However, he found that Roundup®, although an herbicide, actually increased the amount of algae in the pond because it killed most of the frogs.

"It's like killing all the cows in a field and seeing that the field has more grass in it--not because you made the grass grow better, but

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because you killed everything that eats grass," he said.

Previous research had found that the lethal ingredient in Roundup® was not the herbicide itself, glyphosate, but rather the surfactant, or detergent, that allows the herbicide to penetrate the waxy surfaces of plants. In Roundup®, that surfactant is a chemical called polyethoxylated tallowamine. Other herbicides have less dangerous surfactants: For example, Relyea's study found that 2,4-D had no effect on tadpoles.

"We've repeated the experiment, so we're confident that this is, in fact, a repeatable result that we see," said Relyea. "It's fair to say that nobody would have guessed Roundup® was going to be so lethal to amphibians."

Monsanto Comments on Ecological Applications Paper Concerning Amphibians and Roundup Brand Herbicide Formulation

In our view, this paper does not represent realistic use conditions for roundup brand herbicides or other glyphosate-containing formulations for applications to aquatic environments.

A published paper by Rick A. Relyea: The Impact of Insecticides and Herbicides on the Biodiversity and Productivity of Aquatic Communities, Ecological Applications 15 (2) 2005, pp. 618-627

Paper summary: This paper reports the results of a study conducted to determine effects of an unspecified Roundup(r) brand herbicide formulation* (as well as 2, 4-D, carbaryl, and malathion) on an aquatic community containing algae and twenty-five species of aquatic animals including six species of amphibians. The concentration of the Roundup brand herbicide formulation that was tested was 6.4 mL/m2, which is equivalent to 64 L/ha or 27.4 quarts/A. The test was conducted in cattle tanks containing approximately 1000 L of water and no sediment. Nearly complete mortality was observed for tadpoles of the following amphibian species: leopard frog (Rana pipiens), gray tree frog (Hyla versicolor), and the wood frog (Rana sylvatica). The Roundup brand formulation at the tested concentration did not have significant effects on the American toad (Bufo americanus), the spring peeper (Pseudacris crucifer) or the spotted salamander (Ambystoma maculatum).

Monsanto comments can be summarised as follows. These comments have been provided by Monsanto in the UK to New Scientist magazine.

"This study does not represent realistic use conditions for Roundup brand herbicides or other Monsanto glyphosate-containing formulations for applications to aquatic environments, for the following reasons:

1. There are no Roundup brand formulations approved in the US or Canada for application over water. In fact, all current Roundup brand herbicide product labels specifically prohibit application over water. Glyphosate-containing products used for water applications are specifically formulated for this use to enhance their safety to aquatic organisms, such as the organisms studied in this report.

2. The application rate used in this study is unrealistically high, over 7 times the typical use rates for agricultural applications.

3. Finally, previous studies conducted with realistic application methods, glyphosate-containing products have shown no adverse effects on aquatic organisms, including some of those studied in this report."

Notes for further explanation:

A. The "over water" application method used in this study is not a realistic environmental exposure. The direct application of Roundup brand herbicides over water is specifically prohibited by the U.S. or Canadian product labels. The results obtained in this study, therefore, are not representative of results that would be obtained from the terrestrial application of Roundup brand herbicides.

B. Even if direct application to water was permitted, the application rate used in this study is over 7 times greater than typical application rates for agricultural uses (1.5 lb glyphosate acid equivalent {a.e.} per acre) and over 3 times the maximum single application rate for agricultural uses (3.75 lb glyphosate a.e. per acre).

C. The results of this paper are inconsistent with actual field studies conducted with Vision(r) herbicide, which is identical to the Canadian product Roundup Original(r), (Thompson et al., 2004). In the field study, no effect on mortality of the leopard frog, Rana pipiens, or the green frog, Rana clamitans, was observed after aerial application of Vision herbicide at an average application rate of 1.92 kg glyphosate a.e./ha, very near the maximum application rate for conifer release (2.14 kg glyphosate a.e./ha).

D. A risk assessment considering exposure to amphibians and other aquatic organisms demonstrates that terrestrial use of glyphosate formulations is predicted to pose minimal acute and chronic risk to amphibians, including tadpoles (Giesy et al., 2000).

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* Note that although the author refers to the commercial product "Roundup(r)" it is unclear what formulation was actually tested. Monsanto no longer markets a product called simply "Roundup" in the United States or Canada. It is misleading for the author to suggest that "Roundup" and "glyphosate" are synonymous. Roundup is a brand name and numerous formulations are marketed under the Roundup brand name. Some Roundup brand formulations contain active ingredients other than glyphosate.

References: Thompson DG, Wojtaszek BF, Staznik B, Chartrand DT, Stephenson GR. (2004) Chemical And Biomonitoring To Assess Potential Acute Effects Of Vision(r) Herbicide On Native Amphibian Larvae In Forest Wetlands. Environmental Toxicology and Chemistry 23(4): 843-849.

Giesy JP, Dobson S, and Solomon KR. (2000) Ecotoxicological Risk Assessment for Roundup(r) Herbicide. Reviews of Environmental Contamination and Toxicology 167: 35-120.

A recent paper in Ecological Applications (Relyea 2005a) has demonstrated highly lethal effects of the herbicide Roundup on amphibians. The manufacturer of Roundup (Monsanto) has expressed a number of concerns about this study on the Monsanto web site.

Below, Dr. Relyea responds to Monsanto's concerns.

Concern #1: Roundup is only intended for terrestrial use, not aquatic use

While it may be intended for terrestrial use, there is overwhelming evidence that Roundup gets into aquatic habitats, typically through inadvertent (or unavoidable) aerial overspray (Newton et al. 1984, Goldsborough and Brown 1989, Feng et al. 1990, Thompson et al. 2004). To determine the effect on amphibians, Relyea (2005a) simulated a direct overspray of a small wetland using pond mesocosms (1000-liter tanks). The result was widespread death for many species and the death rate was much higher than expected based on previous studies of Roundup.

It is relatively common knowledge that Roundup should not be applied to large ponds and lakes, but it seems to be much less commonly appreciated that many amphibians are not produced in large ponds and lakes due to predation by fish. Instead, small temporary wetlands that may appear to be unimportant and only have 6" of water can, in fact, produce thousands of tadpoles. These small, temporary pools are either not avoided or not avoidable by aerial pesticide applications.

Moreover, Roundup is not only lethal to amphibian larvae. New studies have found that Roundup can be highly lethal to terrestrial amphibians as well (Relyea 2005c).

Concern #2: The application rate of Roundup was 7 times too high

The application rate of 6 ounces per 300 square feet came directly from the label of Monsanto's "Roundup Weed and Grass Killer". What Monsanto is claiming is that the application rate for this Roundup is higher than their listed application rate for other forms of Roundup. However, both application rates come from Monsanto. Moreover, it is well accepted by Monsanto and the applicators of Roundup that some types of weeds require up to four times the recommended application rate to be effective.

Concern #3: The concentration of Roundup used in the experiment was highly unrealistic

Regardless of application rate issues, the real question is whether the concentrations in the water were reasonable. The concentration used by Relyea (2005a) was 3.8 mg a.i./L (milligrams of active ingredient per liter).

Independent researchers (Thompson et al. 2004) have conducted aerial applications of Roundup to control the plants that compete with conifers and found that small wetlands can receive up to 2.6 mg a.i./L. In other natural habitats, Roundup has been detected at concentrations of up to 2.3 mg a.i./L (Newton et al. 1984, Goldsborough and Brown 1989, Feng et al. 1990).

Geisy et al. (2000), in collaboration with Monsanto, predict the maximum concentration for a shallow wetland (6" deep) without any interception by vegetation would be 3.7 mg a.i./L.

Therefore, the concentrations used in the experiment are on the high end, but reasonable according to Monsanto's own calculations. Moreover, subsequent experiments using only one-third as much Roundup (1.3 mg a.i./L, well within expected concentrations) have demonstrated that Roundup can still cause 40% amphibian mortality (Relyea et al. 2005).

Concern #4: A past risk assessment has shown that Roundup poses minimal risk to amphibians

The risk assessment was conducted by Giesy et al. (2000), in cooperation with Monsanto, and the assessment was based on the available data at that time. For amphibians, data only existed for four species of Australian tadpoles and one species of African frog. From these studies, the LC50 estimates (the amount of pesticide needed to kill 50% of the animals) were 4 to 16 mg a.i./L (Mann and Bidwell 1999, Perkins et al. 2000).

More recent LC50 laboratory data for North American amphibians demonstrate that North American amphibians are much more sensitive; LC50 values range from 0.5 to 4.7 mg a.i./L (Edginton et al. 2004, Relyea 2005b). According to U.S. Fish and Wildlife classifications, this means that Roundup can no longer be considered slightly to moderately toxic, but rather moderately to highly toxic to North American amphibians.

Concern #5: The results are not consistent with in-situ studies of amphibians in Canada (Thompson et al. 2004)

The studies of Thompson et al. (2004) and Relyea (2005a) differed in a number of important ways . Thompson et al. (2004) reported mortality rates of green frog and leopard frog tadpoles placed in small cages in ponds after 48 hours of exposure to Roundup. Relyea (2005a) used an almost entirely different set of species (leopard frogs, wood frogs, gray tree frogs, American toads, and spring peepers) and the exposure time was much longer (2 weeks). In addition, Thompson et al.'s tadpoles experienced up to 36% mortality in the highest Roundup concentrations; however, mortality rates across different ponds were not related to Roundup concentrations in the ponds, leaving the high mortality rates unexplained. When there is high and variable mortality (even in the low pesticide ponds), it is difficult to draw strong conclusions from such studies.

Concern#6: The results are not realistic because the pond mesocosms did not contain soil

It is true that the published experiment (Relyea 2005a) used tanks that did not contain soil. This is an important point because soil can absorb pesticides and thereby remove them from the water column. However, in subsequent experiments, Relyea (2005c) examined the effect of adding soil and demonstrated that it made no difference to tadpole survival. Tadpole mortality was 98%, regardless of soil additions.

Concern #7: The study attributes the mortality to the surfactant in Roundup but did not test the surfactant alone

Relyea (2005a) used the commercial form of Roundup (25% glyphosate) containing the POEA surfactant. Agricultural formulations are typically 41% glyphosate, but the glyphosate:surfactant ratio are identical. Previous work in the

Australian species showed that although the Australian species were less sensitive to Roundup, the death that occurred was completely due to the surfactant and not due to the active ingredient (glyphosate). Thus, Relyea's results only apply to formulations that contain this common surfactant and not to other forms of glyphosate (e.g., Rodeo).

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