

Viewpoint: OMG, humans might suffer convulsions from consuming parts-per-trillion of glyphosate? Here's how wild headlines advance the ideological agenda of science-rejecting advocacy groups

Scrolling through the news has become a game of “What Great Horror Did Glyphosate Wreak This Week?” Variations on “Study [first to link](#) weed killer Roundup to convulsions in animals” regularly blaze across the internet. It only took this breathless news release from Florida Atlantic University accompanying an open access study in the journal [Scientific Reports](#).

The headlines and stories that resulted appeared uncritically on hundreds of many mainstream websites (e.g., [here](#), [here](#), [here](#), [here](#), etc.) and on [YouTube](#).

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Anti-biotechnology activists had a field day, as you might guess ([here](#), [here](#)).

The entire paper and the hysteria-grams were based on a study focused on...worms.

What's the context?

Over the past fifty years scientists, many of the activist inclination, have been feeding the weedkiller Roundup and its active ingredient glyphosate to rats, mice, worms, bees and any critter they could jam it into in the mostly futile hope [to find something nefarious](#). The finding most celebrated by critics of the weedkiller, and which is still circulated today, was retracted. Why? Because it manipulated science to try to prove an ideological point — and the authors got caught.

Long term toxicity of a Roundup herbicide and a Roundup-tolerant genetically modified maize

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ABSTRACT

The health effects of a Roundup-tolerant genetically modified maize (from 11% in the diet), cultivated with or without Roundup, and Roundup alone (from 0.1 ppb in water), were studied 2 years in rats. In females, all treated groups died 2–3 times more than controls, and more rapidly. This difference was visible in 3 male groups fed GMO. All results were hormone and sex dependent, and the pathological profiles were comparable. Females developed large mammary tumors almost always more often than and before controls, the pituitary was the second most disabled organ; the sex hormonal balance was modified by GMO and Roundup treatment. In treated males, liver congestions and necrosis were 2.5–5.5 times higher. This pathology was confirmed by optic and transmission electron microscopy. Marked and severe kidney nephropathies were also generally 1.3–2.3 greater. Males presented 4 times more large palpable tumors than controls which occurred up to 600 days earlier. Biochemistry data confirmed very significant kidney chronic deficiencies; for all treatments and both sexes, 76% of the altered parameters were kidney related. These results can be explained by the non linear endocrine-disrupting effects of Roundup, but also by the overexpression of the transgene in the GMO and its metabolic consequences.

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1. Introduction

There is an ongoing international debate as to the necessary length of mammalian toxicity studies in relation to the consumption of genetically modified (GM) plants including regular metabolic analyses (Seralini et al., 2011). Currently, no regulatory authority requests mandatory chronic animal feeding studies to be performed for edited crops and formulated pesticides. However, several studies consisting of 90 day rat feeding trials have been conducted by the biotech industry. These investigations mostly concern GM soy and maize that are rendered either herbi-

cide tolerant (to Roundup (R) in 80% of cases), or engineered to produce a modified *Bt* toxin insecticide, or both. As a result these GM crops contain new pesticide residues for which new maximal residual levels (MRL) have been established in some countries.

If the petitioners conclude in general that there is no major change in genetically modified organism (GMO) subchronic toxicity studies (Domingo and Giné Bordonaba, 2011; Hammond et al., 2004, 2006a,b), significant disturbances have been found and may be interpreted differently (Seralini et al., 2009; Spiroux de Vendômois et al., 2010). Detailed analyses have revealed alterations in kidney and liver functions that may be the signs of early chronic diet intoxication, possibly explained at least in part by pesticide residues in the GM feed (Seralini et al., 2007; Spiroux de Vendômois et al., 2009). Indeed, it has been demonstrated that R concentrations in the range of 10^3 times below the MRL induced endocrine disturbances in human cells (Gasnier et al., 2009) and toxic effects thereafter (Benachour and Seralini, 2009), including

Abbreviations: GM, genetically modified; R, Roundup; MRL, maximal residual levels; GMO, genetically modified organism; OECD, Organization for Economic Co-operation and Development; GT, glutamyl-transferase; PCA, principal component analysis; PLS, partial least-squares; OPLS, orthogonal partial least-squares; NIPALS, Nonlinear Iterative Partial Least Squares; OPLS-DA, Orthogonal Partial Least Squares Discriminant Analysis; G. elvcozen: L. lipid droplet; N. nucleus; R. rough endoplasmic

Over the years, in an attempt to 'prove' glyphosate's danger, scientists delivered massive doses through tubes directly into the stomach and injecting it directly into the abdomens of rodents. In the hundreds of

papers in which animals have been exposed to these unrealistically high doses there has been no mention of convulsions, except in some case studies where people drank huge amounts of the concentrate in failed suicide attempts. A systematic [review](#) of 27 studies released last year focused on whether glyphosate had any neurological effects in animals, published in June, shows little reliable evidence of impacts.

Review

Glyphosate and neurological outcomes: A systematic literature review of animal studies

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On top of that, while we're constantly reminded that there is more glyphosate applied than ever before, there are no trends of applicators and farmers breaking out in seizures (if there were, you can be assured they'd be the subject of high-profile lawsuits).

So being the "first to link" glyphosate to animal convulsions either means: (a) everyone else must have missed it for half a century; or (b) it could be an observation dependent on the experiment or the organism being tested. But presenting a measured analysis and making it clear that literally no other of the 3,000+ studies on glyphosate over more than 50 years has reached a similar conclusion, is not nearly as much fun as a new horror story.

What did the report really say?

The headlines suggested that the herbicide was "harmful" and was "linked" to convulsions in "animals". Is that true?

[The report by Naraine et al](#) examined the recovery of *C. elegans* (a laboratory version of a ubiquitous microscopic soil worm) after an electric shock. When the worms are pulsed with electricity they go into a seizure, breaking their normal swimming behaviors. The time to recover from the shock was recorded. The researchers observed that shock-induced paralysis lasted longer when worms were bathed in glyphosate. In other words, glyphosate did not cause the convulsions as many headlines inferred.



Credit: Bob Goldstein / University of North Carolina-Chapel Hill.

The researchers then went on to test recovery in the presence of specific drugs or genetic mutations that could block or hypersensitize discrete neurotransmitter receptors in the worm's rudimentary nervous system of 302 neurons. The results were consistent with glyphosate interfering with a specific neurotransmitter and/or its receptor, the GABA-A receptor, to cause the augmented recovery time. The scientists used both genetics and drugs to affect the response, a strong approach that helps pinpoint a mechanism of how glyphosate affects electroshock recovery.

Unlike other reports where researchers pack animals full of herbicide and measure effects, the researchers here were careful to test a series of glyphosate formulations at relatively low concentrations, some that a nematode might realistically encounter in an ecological setting. They also independently

tested the surfactants: the detergent-like molecules in Roundup that help the herbicide penetrate the waxy coating of leaves. These didn't extend electrically-induced convulsions. Glyphosate alone did, even in the absence of the surfactant.

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My major criticism of the paper is in the easy-to-misinterpret presentation of data in bar graphs that overlaid the individual data points. There is a lot of variation in the response between worms, and the researchers only reported an average. When looking at the data in most experiments they appear almost random, with wide variation in worm behavior in both glyphosate treatments and saline controls. The average recovery time was longer in the presence of the herbicide—but that seems to be dependent on a few worms convulsing longer, not all worms showing a change. Measuring the timing of worm wiggles might be tricky business, and larger data sets might refine the differences observed.

So, let's give the benefit of the doubt to the authors and conclude the glyphosate treated worms convulse longer and do so in a way that is dependent on a specific neurotransmitter. But let's ostracize the sensational headlines about "dramatic findings" and the thousands of social media references and retweets hyping the glyphosate-seizure link, especially those claiming it is a basis of convulsions in "animals".

Nova Southeastern University, one of the schools involved in the research, wins the award for irresponsibly generating unwarranted concern. Here's its [news release](#);

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Before even introducing the study, Nova unscrupulously hyped a totally unrelated routine CDC release in July that found more than 80% of urine samples of Americans contained micro-traces of glyphosate—data blown way out of proportion, as I addressed in an article on the [Genetic Literacy Project here](#).

Then the release breathlessly moved on to the worm study. Did the researchers really find something earth-shaking as its coverage suggested? Is glyphosate “potentially more dangerous than previously thought”? Should we rely on a study in an invertebrate model that does not match what has been observed in more complex animals with nervous systems much more similar to humans?

[Other compounds](#) known to affect specific neurotransmitters have been tested in *C. elegans* and [show similar results](#) with recovery time, so this is nothing new. What earth shaking nugget of information did the researchers in this case actually find? That “glyphosate and Roundup ... generate concerns” over how they “might affect soil-dwelling organisms like *C. elegans*”—microscope soil worms. That’s the substance of the conclusion before the anti-glyphosate attack market went into high gear. To speculate that based on this study that animals including humans might be at risk is a long stretch.

We will never expect contextualized coverage of this otherwise forgettable worm study by advocacy groups like GM Watch, which predictably [hyped](#) the study in headlines accompanied by wild implications from one of the news releases, that glyphosate “could lead to neurodegenerative diseases such as Parkinson’s”—findings not found in some 3,000+ studies on glyphosate to date.



News and comment on genetically modified foods and their associated pesticides



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Roundup: World’s most popular weedkiller linked to convulsions in animals for first time

That’s not what the study addressed, and nor can its impact on other animals or humans be inferred from sparse data obtained from an electroshocked microscopic worm bathed in herbicide. That’s pure speculation, and irresponsible.

What are we to take away from this all-to-familiar glyphosate-will-harm-you “news” melodrama? It means that serious readers—and editors of responsible news publications—need to actually read a scientific paper before writing a headline or pushing out a tweet.

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Disclosure re Kevin Folta: According to [Wikipedia](#), the University of Florida received a \$25,000 grant from Monsanto to be used at the university’s discretion which was earmarked for an established biotechnology communication program. Kevin Folta submitted expense reports to use the biotechnology communication fund to pay for travel expenses, a small projector, coffee and food. Most of these expenses had since been reimbursed to the fund with honoraria from his talks and private donations from individuals and small businesses, while none of the donation from Monsanto was used. In October 2015, [Nature Biotechnology](#) wrote that scientists like Folta have been “targeted because they speak inconvenient truths about GM technology” and stated that the

funds “were tied neither to [Folta] directly nor to his research. His conflict of interest disclosures were wholly compliant with his university’s rules. He never used industry funds for personal gain.”

Disclosure re Genetic Literacy Project: The Genetic Literacy Project, founded in 2011, has been accused by some anti-biotechnology advocates funded by the organic industry of being a ‘[PR front for Monsanto](#)’. That allegation is false. The GLP is totally independent. The GLP did not accept a donation from a large agro-biotech company until 2020 during the COVID recession. The GLP outlines its donation policy on its [transparency page](#).