

# Glyphosate: *The World's Most Controversial Herbicide*

J. Ferrell

University of Florida - IFAS



# What is glyphosate?

- Active ingredient in the world's most commonly used herbicide



[https://www.huffingtonpost.com/entry/new-claims-against-monsanto-in-consumer-lawsuit-over\\_us\\_59496379e4b0f500e5526088](https://www.huffingtonpost.com/entry/new-claims-against-monsanto-in-consumer-lawsuit-over_us_59496379e4b0f500e5526088)

# Why is glyphosate so common?

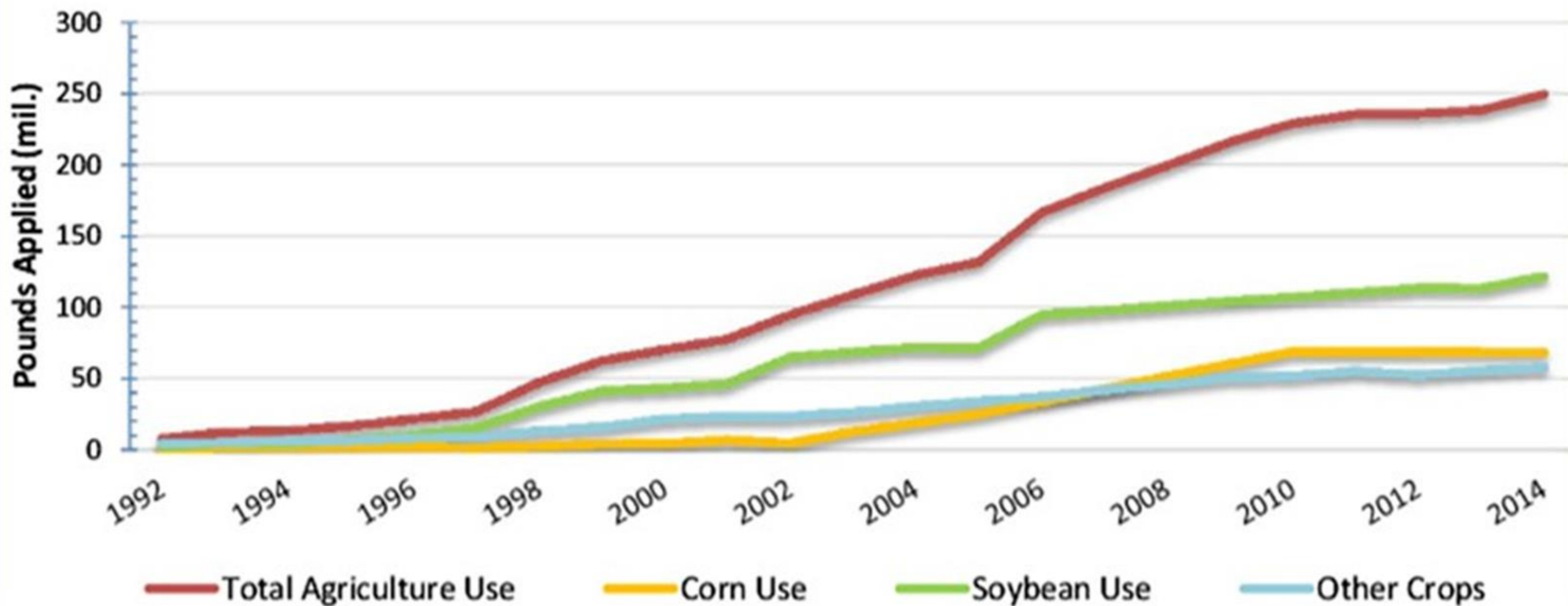
- In many respects, it is the perfect herbicide
  - Non-selective
  - Non-volatile
  - No odor
  - Non-staining
  - No soil carryover
  - Highly effective
  - Inexpensive





[http://www.fmccrop.com/Portals/\\_default/fmc\\_images/product\\_assets/cadet\\_broadleaf\\_weed\\_control.jpg](http://www.fmccrop.com/Portals/_default/fmc_images/product_assets/cadet_broadleaf_weed_control.jpg)

### Glyphosate Pounds Applied



We are applying 250 million lbs. a year? That can't be good, right?

Not Safe To Eat: Rate For Lifetime Of

Grow

Arch. Environ. Contam. Toxicol. 48, 351–357 (2005)  
DOI: 10.1007/s00244-004-0086-0

ARCHIVES OF  
**Environmental  
Contamination  
and Toxicology**  
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## The Lethal Impacts of Roundup and Predatory Stress on Six Species of North American Tadpoles

R. A. Relyea

Department of Biological Sciences, University of Pittsburgh, Pittsburgh, PA 15260, USA

Received: 22 April 2004 / Accepted: 3 July 2004

Managers rely on glyphosate, but are we killing ourselves in the process?

## **The Lethal Impacts of Roundup and Predatory Stress on Six Species of North American Tadpoles**

R. A. Relyea

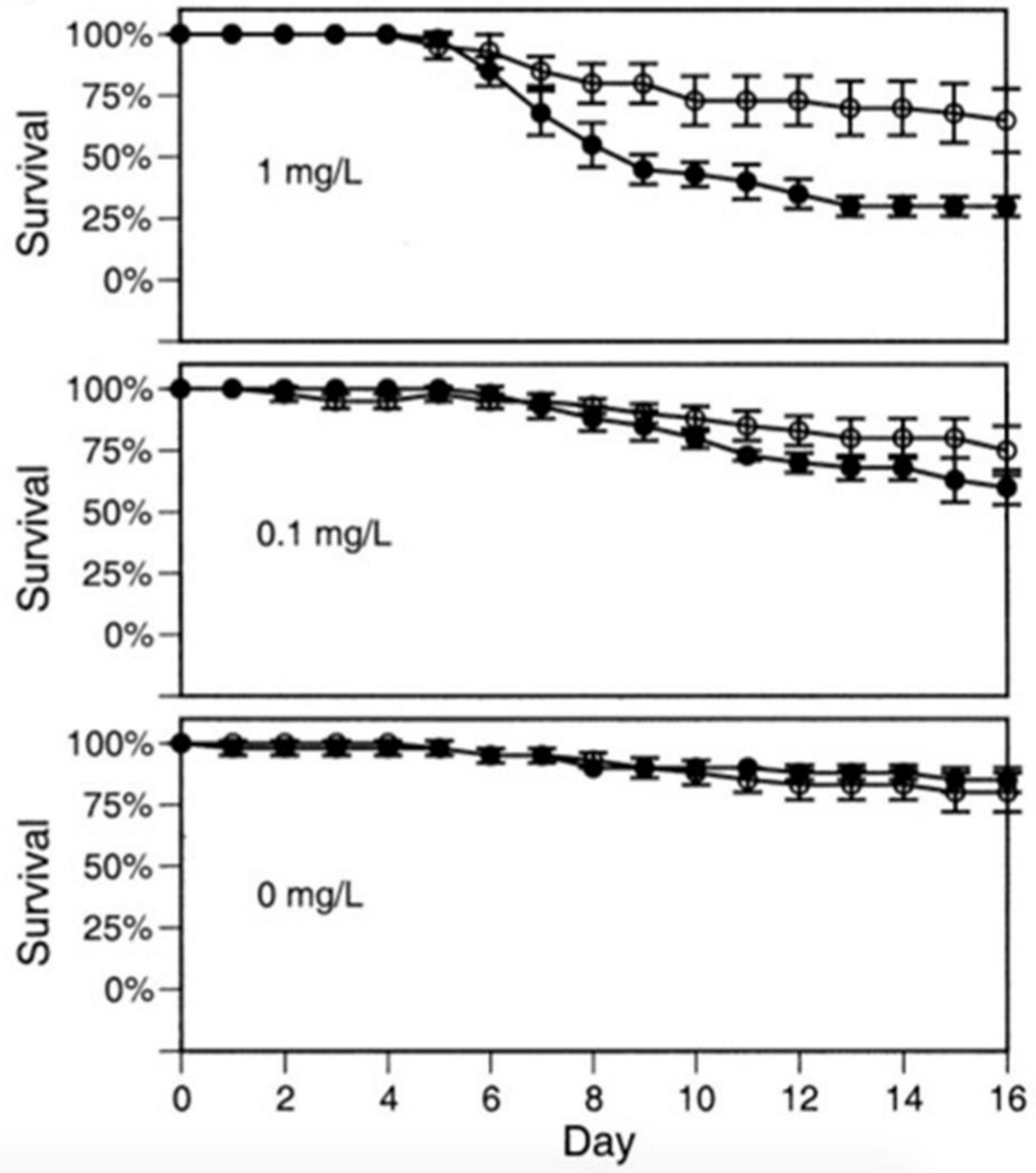
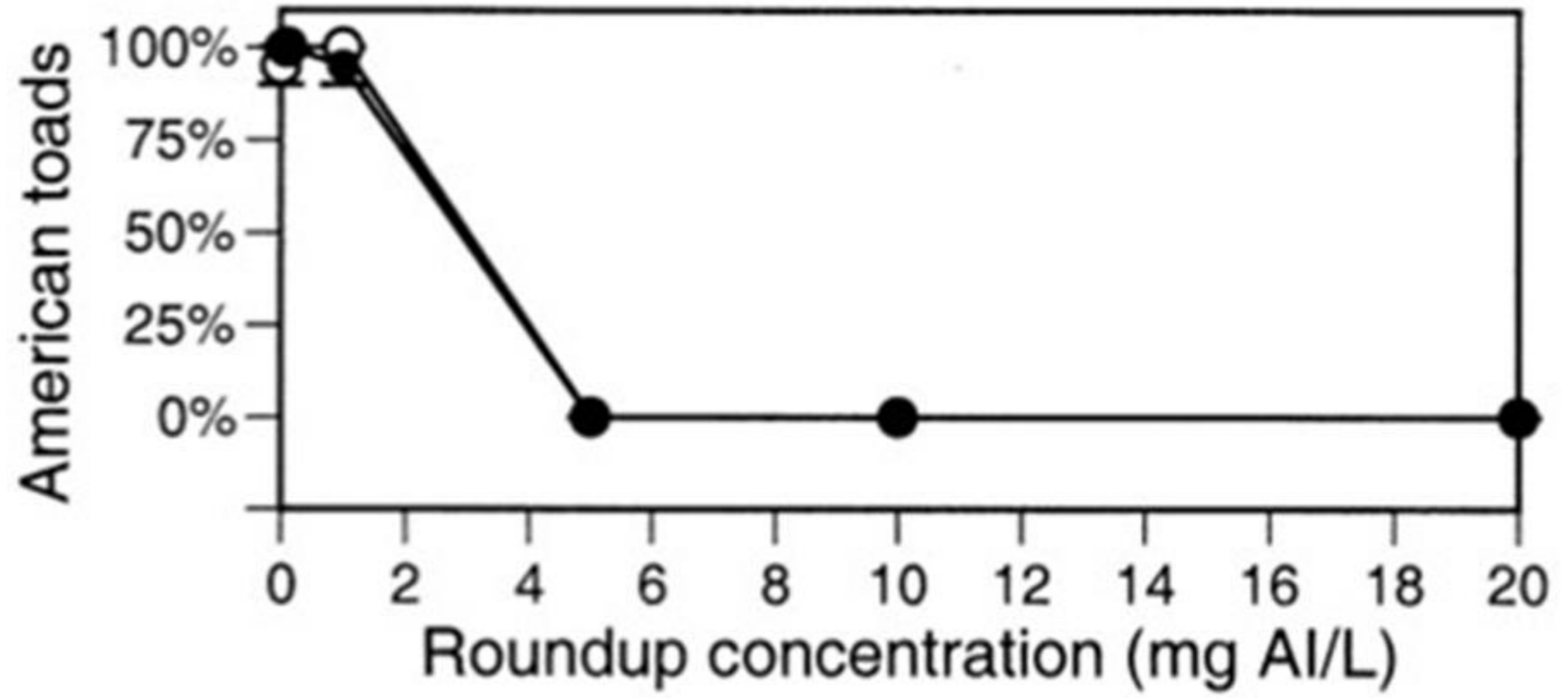
Department of Biological Sciences, University of Pittsburgh, Pittsburgh, PA 15260, USA

Received: 22 April 2004 / Accepted: 3 July 2004

- Background
  - Amphibian numbers world-wide were declining
  - Asked if global rise in glyphosate use could be a factor



# What did he find?



# Why are we still using so much Roundup if it is so toxic to frogs?

- His study didn't simulate real world conditions.
- He used Roundup, which cannot be legally applied to water because it contains a toxic soap to help improve uptake by plants.



## 2.0 IMPORTANT PHONE NUMBERS

1. FOR PRODUCT INFORMATION OR ASSISTANCE IN USING THIS PRODUCT,  
CALL TOLL-FREE, 1-800-332-3111  
2. IN CASE OF AN EMERGENCY INVOLVING THIS HERBICIDE PRODUCT, OR FOR MEDICAL ASSISTANCE, CALL COLLECT, DAY OR NIGHT,  
(314) 694-4000

## 3.0 PRECAUTIONARY STATEMENTS

### 3.1 Hazards to Humans and Domestic Animals

Keep out of reach of children  
**CAUTION!**

## 3.2 Environmental Hazards

Do not apply directly to water, to areas where surface water is present or to intertidal areas below the mean high water mark. Do not contaminate water when cleaning equipment or disposing of equipment wash waters and rinsate.

# He should have used an aquatic glyphoc

2119514-25



## Complete Directions for Use in Aquatic and Other Non-crop Sites.

AVOID CONTACT OF HERBICIDE WITH FOLIAGE, STEMS, EXPOSED NON-WOODY ROOTS OR FRUIT OF CROPS, DESIRABLE PLANTS AND TREES, BECAUSE SEVERE INJURY OR DESTRUCTION MAY RESULT.

EPA Reg. No. 524-343

2009-2

Read the entire label before using this product.

Use only according to label instructions.

Not all products listed on this label are registered for use in California. Check the registration status of each product in California before using.

Read the "LIMIT OF WARRANTY AND LIABILITY" statement at the end of the label before buying or using. If terms are not acceptable, return at once unopened.

THIS IS AN END-USE PRODUCT. MONSANTO DOES NOT INTEND AND HAS NOT REGISTERED IT FOR REFORMULATION (OR REPACKAGING). SEE INDIVIDUAL CONTAINER LABEL FOR REPACKAGING LIMITATIONS.

### PRODUCT INFORMATION

## 1.0 INGREDIENTS

#### ACTIVE INGREDIENT:

\*Glyphosate, N-(phosphonomethyl)glycine, in the form of its isopropylamine salt..... 53.8%

OTHER INGREDIENTS:..... 46.2%  
100.0%

## 3.2 Environmental Hazards

Do not contaminate water when cleaning equipment or disposing of equipment washwaters. Treatment of aquatic weeds can result in oxygen depletion or loss due to decomposition of dead plants. This oxygen loss can cause fish suffocation.

In case of: SPILL or LEAK, soak up and remove to a landfill.

## 3.3 Physical or Chemical Hazards

Spray solutions of this product should be mixed, stored and applied using only stainless steel, fiberglass, plastic or plastic-lined steel containers.

DO NOT MIX, STORE OR APPLY THIS PRODUCT OR SPRAY SOLUTIONS OF THIS PRODUCT IN GALVANIZED STEEL OR UNLINED STEEL (EXCEPT STAINLESS STEEL) CONTAINERS OR SPRAY TANKS. This product or spray solutions of this product react with such containers and tanks to produce hydrogen gas which may form a highly combustible gas mixture. This gas mixture could flash or explode, causing serious personal injury, if ignited by open flame, spark, welder's torch, lighted cigarette or other ignition source.

### DIRECTIONS FOR USE

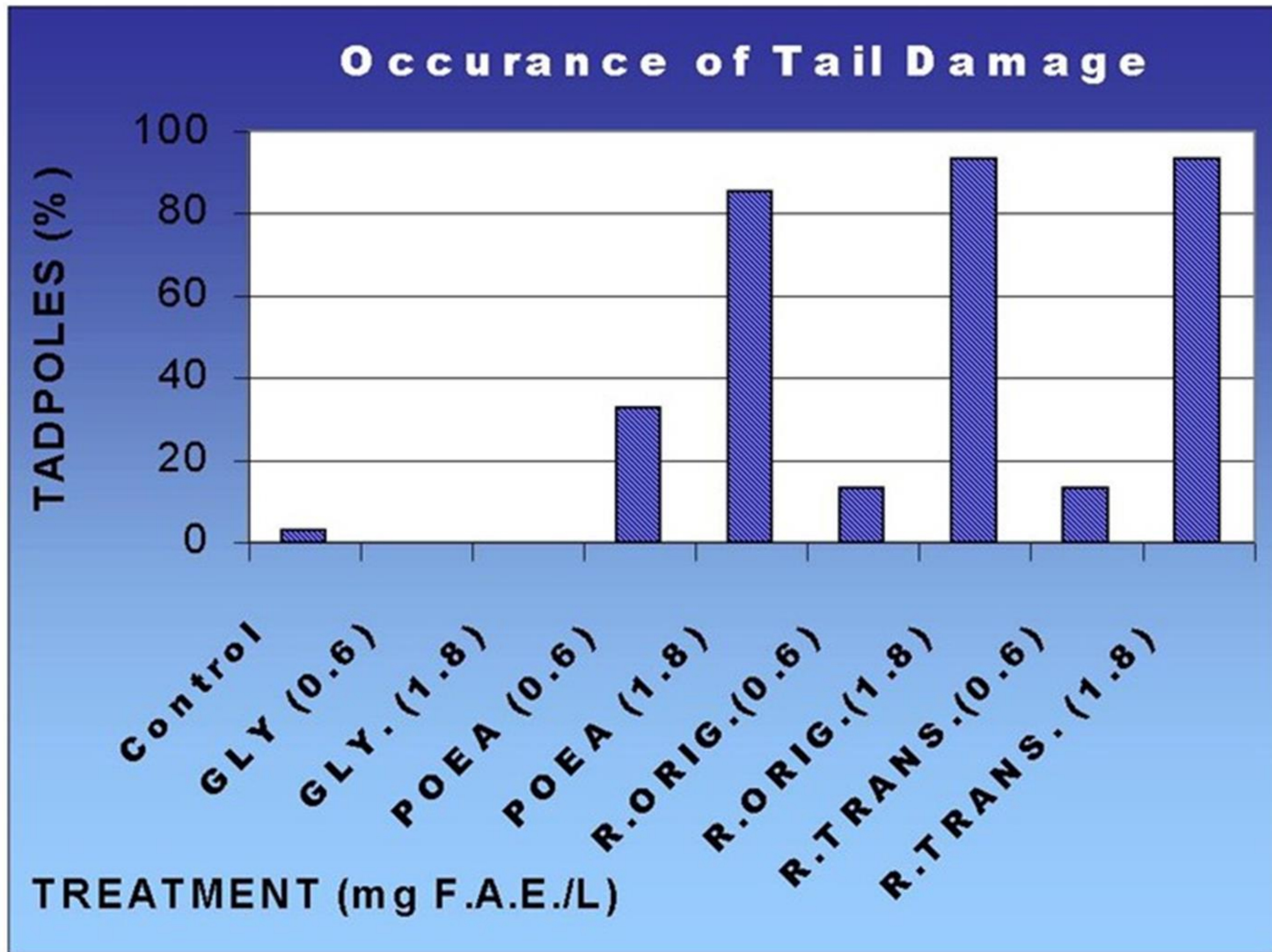
It is a violation of Federal law to use this product in any manner inconsistent with its labeling. This product can only be used in accordance with the Directions for Use on this label or in separately published Monsanto Supplemental Labeling. Supplemental labeling can be found on the [www.cdms.net](http://www.cdms.net) or [www.greenbook.net](http://www.greenbook.net) websites or obtained by contacting your Authorized Monsanto Retailer or Monsanto Company representative. For any requirements specific to your State or Tribe, consult the agency responsible for pesticide regulations.

## 4.0 STORAGE AND DISPOSAL

Proper pesticide storage and disposal are essential to protect against exposure to people and the environment due to leaks and spills, excess product or waste, and vandalism. Do not allow this product to contaminate water, foodstuffs, feed or seed by storage and disposal.

**PESTICIDE STORAGE:** STORE ABOVE 5°F (-15°C) TO KEEP PRODUCT FROM CRYSTALLIZING. Crystals will settle to the bottom. If allowed to crystallize, place in a warm room 68°F (20°C) for several days to redissolve and roll or shake container or recirculate in mini-bulk containers to mix well before using. Store pesticides away from food, pet food, feed, seed, fertilizers, and veterinary supplies. Keep container closed to prevent leaks and contamination.

A critical question in interpreting the results of the aquatic and terrestrial experiments is whether the high rates of mortality observed were due to the active ingredient of Roundup (glyphosate) or whether they were due to the added surfactant (POEA). As discussed above, laboratory studies have shown that glyphosate alone has a low toxicity while the POEA surfactant can be highly toxic to a variety of taxa including amphibians (Mann and Bidwell 1999, Giesy et al. 2000, Perkins et al. 2000, Lajmanovich et al. 2003, Tsui and Chu 2003, Edginton et al. 2004, Howe et al. 2004). The current study did not isolate the impacts of glyphosate and the surfactant, so one cannot determine which component of Roundup caused the mortality, but it seems likely that the surfactant was the cause. What is clear



We have known that the soap in Roundup is toxic to frogs since 1978 when it was first registered

- This is why the EPA has NEVER allowed “Roundup” to be applied to water. You must use an aquatic friendly glyphosate.

What if we accidentally  
spray with the wrong  
glyphosate?

## CHEMICAL AND BIOMONITORING TO ASSESS POTENTIAL ACUTE EFFECTS OF VISION® HERBICIDE ON NATIVE AMPHIBIAN LARVAE IN FOREST WETLANDS

DEAN G. THOMPSON,\*† BARBARA F. WOJTASZEK,‡ BOZENA STAZNIK,† DEREK T. CHARTRAND,† and  
GERALD R. STEPHENSON‡

†Natural Resources Canada–Canadian Forest Service, Sault St. Marie, Ontario P6A 2E5, Canada  
‡Department of Environmental Biology, University of Guelph, Guelph, Ontario N1G 2W1, Canada

*(Received 19 June 2002; Accepted 16 September 2003)*

“Results suggest that exposures typically occurring in forest wetlands are insufficient to induce significant acute mortality in native amphibian larvae.”



# What about the cancer risk?



Contents lists available at [SciVerse ScienceDirect](#)

Food and Chemical Toxicology

journal homepage: [www.elsevier.com/locate/foodchemtox](http://www.elsevier.com/locate/foodchemtox)



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

Gilles-Eric Séralini<sup>a,\*</sup>, Emilie Clair<sup>a</sup>, Robin Mesnage<sup>a</sup>, Steeve Gress<sup>a</sup>, Nicolas Defarge<sup>a</sup>,  
Manuela Malatesta<sup>b</sup>, Didier Hennequin<sup>c</sup>, Joël Spiroux de Vendômois<sup>a</sup>

<sup>a</sup> University of Caen, Institute of Biology, CRIIGEN and Risk Pole, MRSH-CNRS, EA 2608, Esplanade de la Paix, Caen Cedex 14032, France

<sup>b</sup> University of Verona, Department of Neurological, Neuropsychological, Morphological and Motor Sciences, Verona 37134, Italy

<sup>c</sup> University of Caen, UR ABTE, EA 4651, Bd Maréchal Juin, Caen Cedex 14032, France

# What about the cancer risk?

## Not Safe To Eat: Rats Fed Lifetime Of GMO Corn Grow Horrifying Tumors, Die Very Early



ScienceDirect

Toxicology

locate/foodchemtox



Roundup-tolerant

Mass<sup>a</sup>, Nicolas Defarge<sup>a</sup>,  
Mois<sup>a</sup>

<sup>a</sup> Caen Cedex 14032, France

<sup>b</sup> Verona 37134, Italy

<sup>a</sup> University of Caen, UR ABTE, EA 4651, Bd Maréchal Juin, Caen Cedex 14032, France

**Table 1** Mortality (by euthanasia or spontaneous mortality) in different groups of 10 rats, separated by the amount of maize in the diet (from Séralini et al. 2012)

Diet	Dose (%)	Number of dead males (n = 10)	Number of dead females (n = 10)
Conventional maize	33	3	2
GM maize	11	5	3
	22	1	7
	33	1	4
GM maize plus Roundup™	11	4	4
	22	5	7
	33	3	4

THE SCIENTIFIC ARTICLE CLAIMS TO ADDRESS THE TOXICITY OF herbicide-tolerant GM maize in the diet, with or

**Table 2** Mortality (by euthanasia or spontaneous mortality) in different groups of 10 rats separated by the amount of Roundup™ in the drinking water A: B: C: 0.5 % (from Séralini et al. 2012)

Group	Dose	Number of dead males (n = 10)	Number of dead females (n = 10)
No herbicide	0	3	2
Herbicide in drinking water	$1.1 \times 10^{-6}$ %	3	5
	0.09 %	4	5
	0.5 %	1	4

The study has been heralded as “the most thorough research ever published into the health effects of ... the herbicide Roundup on rats.”



# Rebuttal

Transgenic Res (2013) 22:255–267

DOI 10.1007/s11248-013-9692-9

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PERSPECTIVE

## **Plurality of opinion, scientific discourse and pseudoscience: an in depth analysis of the Séralini et al. study claiming that Roundup<sup>TM</sup> Ready corn or the herbicide Roundup<sup>TM</sup> cause cancer in rats**

**Gemma Arjó · Manuel Portero · Carme Piñol · Juan Viñas ·  
Xavier Matias-Guiu · Teresa Capell · Andrew Bartholomaeus ·  
Wayne Parrott · Paul Christou**

# Rebuttal

- Used the wrong rats
  - Sprague-Dawley rats
- Too few animals in the study
- Unethical treatment of test subjects
- ...In all 2.5 pages of errors were noted.
  
- Suggests that improper conclusions were drawn

# Result



## Food and Chemical Toxicology

Volume 50, Issue 11, November 2012, Pages 4221-4231



### **RETRACTED: Long term toxicity of a Roundup herbicide and a Roundup-tolerant genetically modified maize**

Gilles-Eric Séralini<sup>a</sup>,  , Emilie Clair<sup>a</sup>, Robin Mesnage<sup>a</sup>, Steeve Gress<sup>a</sup>, Nicolas Defarge<sup>a</sup>, Manuela Malatesta<sup>b</sup>, Didier Hennequin<sup>c</sup>, Joël Spiroux de Vendômois<sup>a</sup>

## BUSINESS DAY

# W.H.O. Report Links Ingredient in Roundup to Cancer

By REUTERS MARCH 20, 2015



The world's most widely-used weed killer can "probably" cause [cancer](#), the [World Health Organization](#) said on Friday.

The organization's cancer arm, the International Agency for Research on Cancer, said glyphosate, the active ingredient in the [Monsanto](#) herbicide Roundup, was "classified as probably carcinogenic to humans." It also said there was "limited evidence" that glyphosate was carcinogenic in humans for non-Hodgkin lymphoma.

Monsanto, the world's largest seed company, said scientific data did not support the conclusions and called on the group to hold a meeting to explain the findings.

"We don't know how IARC could reach a conclusion that is such a dramatic departure from the conclusion reached by all regulatory agencies around the globe," Philip Miller, Monsanto's vice-president for global regulatory affairs, said in a statement.

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# World Health Organization

- March 2015, IARC reclassified glyphosate as “Probably Carcinogenic”
- First...what is IARC?

# IARC: International Agency for Research on Cancer

- IARC is a fairly independent branch within WHO.
- “Its role is to conduct and coordinate research into the causes of cancer. It also collects and publishes surveillance data regarding the occurrence of cancer worldwide.”

[https://en.wikipedia.org/wiki/International\\_Agency\\_for\\_Research\\_on\\_Cancer](https://en.wikipedia.org/wiki/International_Agency_for_Research_on_Cancer)

# Known vs. Probable Carcinogens

## Known

- Alcoholic beverages
- Asbestos
- Tobacco
- Plutonium
- Solar Radiation
- UV Tanning Beds

*<http://www.cancer.org/cancer/cancercauses/othercarcinogens/generalinformationaboutcarcinogens/known-and-probable-human-carcinogens>*

# Known vs. Probable Carcinogens

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## Probable

- Glyphosate
- Hair products (work exposure)
- Red Meat (consumption)
- Beverages >150 F (consump.)
  - McDonald's coffee (180-190F)
- Shiftwork (circadian disruption)

# Why are things like hair products and shiftwork listed?

- Can we say that almost everything IARC tests comes back positive?
- “Over four decades, a WHO research agency has assessed 989 substances and activities, ranging from arsenic to hairdressing, and found only one was “probably not” likely to cause cancer in humans. It was an ingredient in nylon used in stretchy yoga pants and toothbrush bristles.”

<https://www.reuters.com/investigates/special-report/health-who-iarc/>

# What does “Probably Carcinogenic” mean?

“There is *limited* evidence of carcinogenicity in humans and *sufficient* evidence in experimental animals.”

Or

“... *strong* evidence that the carcinogenesis is mediated by a mechanism that also operates in humans.”

<http://monographs.iarc.fr/ENG/Preamble/CurrentPreamble.pdf>

But the question remains, why was glyphosate only recently put on this list?

Do the data support this?

# WHO revisited this subject in May 2016



Food and Agriculture Organization  
of the United Nations



World Health  
Organization

## **JOINT FAO/WHO MEETING ON PESTICIDE RESIDUES**

**Geneva, 9–13 May 2016**

**SUMMARY REPORT**

*Issued 16 May 2016*



# Conclusion from May 2016 review

*“The Meeting concluded that glyphosate is not carcinogenic in rats”*

*“Meeting concluded that glyphosate is unlikely to pose a carcinogenic risk to humans from exposure through the diet.”*

<http://www.who.int/foodsafety/jmprsummary2016.pdf?ua=1>

# The EPA agrees



## EPA Weighs In On Glyphosate, Says It Likely Doesn't Cause Cancer

September 17, 2016 · 9:49 AM ET



DAN CHARLES



# In their 240 page review of glyphosate...

*The available data at this time do not support a carcinogenic process for glyphosate.*

*Overall, animal carcinogenicity and genotoxicity studies were remarkably consistent and did not demonstrate a clear association between glyphosate exposure and outcomes of interest related to carcinogenic potential.*

[https://www.epa.gov/sites/production/files/2016-09/documents/glyphosate\\_issue\\_paper\\_evaluation\\_of\\_carcinogenic\\_potential.pdf](https://www.epa.gov/sites/production/files/2016-09/documents/glyphosate_issue_paper_evaluation_of_carcinogenic_potential.pdf)

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# Europe has finally changed course



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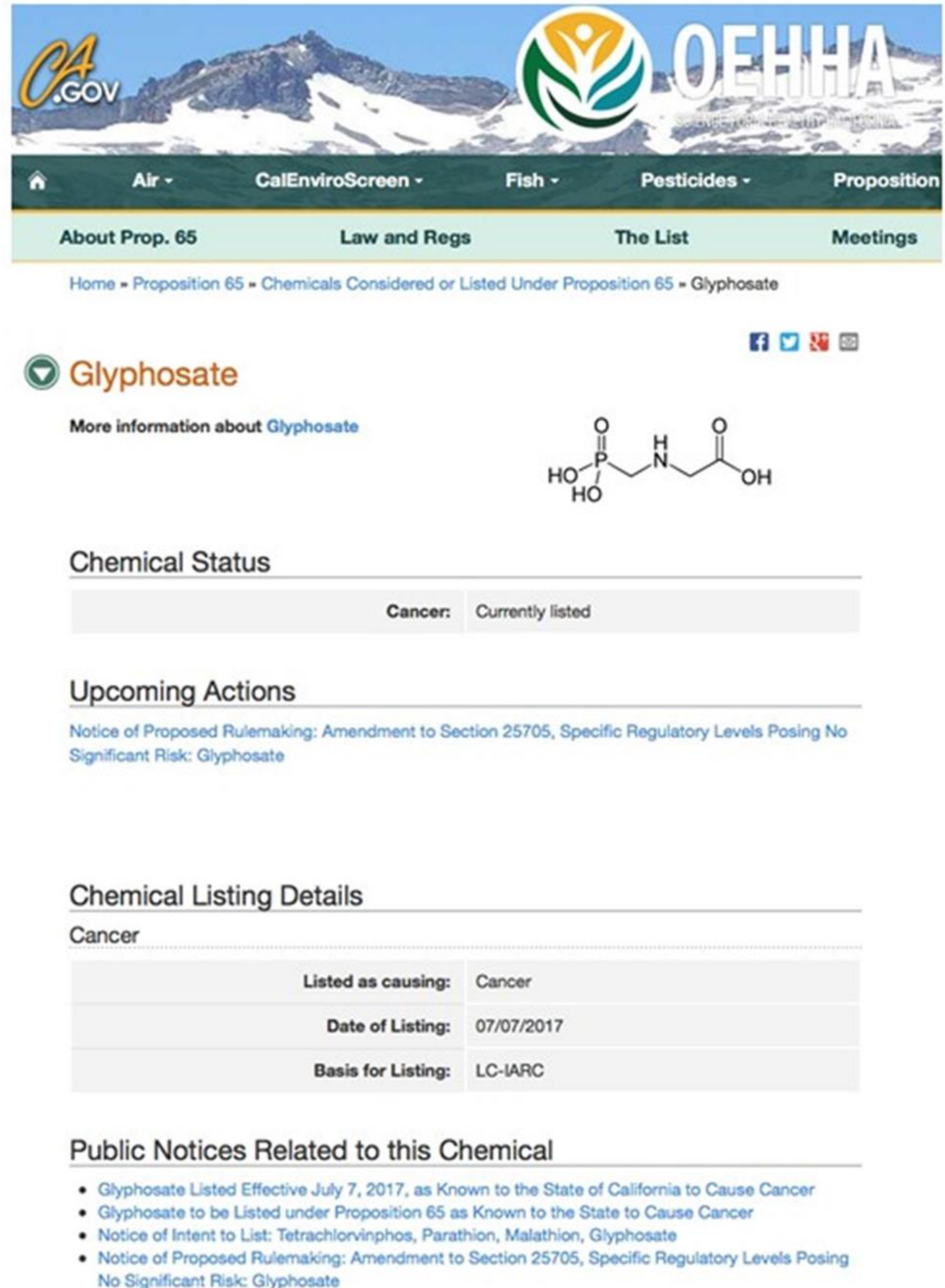
## Controversial weedkiller in Roundup 'does not cause cancer', says European expert committee

'The overwhelming weight of evidence shows that glyphosate poses no risk to human health when used correctly,' says farmers' leader

March 2017

# California Office of Environment Health Hazard Assessment

July 2017, proposes warning label under Prop 65



The screenshot shows the website for the California Office of Environment Health Hazard Assessment (OEHHA). The page is titled "Glyphosate" and provides information about its chemical status and upcoming actions. The chemical structure of Glyphosate is shown as OC(=O)CNCP(=O)(O)O. The page also includes a table of chemical listing details and a list of public notices related to this chemical.

**Chemical Status**

<b>Cancer:</b>	Currently listed
----------------	------------------

**Upcoming Actions**

[Notice of Proposed Rulemaking: Amendment to Section 25705, Specific Regulatory Levels Posing No Significant Risk: Glyphosate](#)

**Chemical Listing Details**

Cancer	
<b>Listed as causing:</b>	Cancer
<b>Date of Listing:</b>	07/07/2017
<b>Basis for Listing:</b>	LC-IARC

**Public Notices Related to this Chemical**

- [Glyphosate Listed Effective July 7, 2017, as Known to the State of California to Cause Cancer](#)
- [Glyphosate to be Listed under Proposition 65 as Known to the State to Cause Cancer](#)
- [Notice of Intent to List: Tetrachlorvinphos, Parathion, Malathion, Glyphosate](#)
- [Notice of Proposed Rulemaking: Amendment to Section 25705, Specific Regulatory Levels Posing No Significant Risk: Glyphosate](#)

# California pushes for warning labels

- Proposition 65 - *Safe Drinking Water and Toxic Enforcement Act*, passed by voters in 1986.
- “Proposition 65 requires that employees and consumers be warned when they are exposed to a chemical listed as “known” to cause cancer or reproductive harm”

<https://chemicalwatch.com/64457/us-court-rules-on-glyphosate-labelling-threatening-reach-of-prop-65>

# WARNING

Chemicals known to the State of California to cause cancer, birth defects, and other reproductive harm are present in jet engine exhaust, fumes from jet fuel, and exhaust from equipment used to service airplanes. Sometimes these chemicals enter this jet bridge



# Ag industry pushes back

“agricultural industry groups sued the state, alleging that a warning label on food would violate 1<sup>st</sup> Amendment free speech protections by compelling retailers to post "false, misleading and highly controversial statements" on their products.”

*<http://www.latimes.com/business/la-fi-glyphosate-prop65-story.html>*

# California Court blocks warning label

## Glyphosate cancer warning in California halted

LA  
Times

By GEOFFREY MOHAN FEB 27, 2018 | 1:15 PM



<http://www.latimes.com/business/la-fi-glyphosate-prop65-story.html>

# Judge Shubb - ruling

- Shubb said a cancer warning would be "misleading at best," given that "a reasonable consumer would not understand that a substance is 'known to cause cancer' where only one health organization had found that the substance in question causes cancer and virtually all other government agencies and health organizations that have reviewed studies on the chemical had found there was no evidence that it caused cancer."

<http://www.latimes.com/business/la-fi-glyphosate-prop65-story.html>

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(nivolumab)

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INDICATION  
OPDIVO® (nivolumab) is a prescription medicine used to  
treat people with a type of advanced stage lung cancer  
(called non-small cell lung cancer) that has spread or  
Medication Guide • U.S. Full Prescribing Information

# Coffee may come with a cancer warning label in California



Emily Christensen, CNN

Updated 3:42 PM ET, Fri March 30, 2018



Coffee may require cancer warning label 01:41

## Story highlights

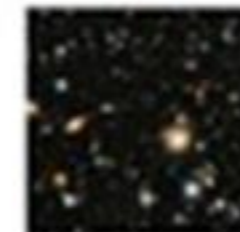
A California judge ruled against coffee shops that may have to label their product

**(CNN)** — A preliminary decision from a California superior court judge in Los Angeles could affect thousands of coffee shops including Starbucks, 7-Eleven

### More from CNN



These teachers work up to 6 jobs. Now they're fed up and ready...



Why the universe shouldn't exist at all

Are you confident you have the lowest mortgage rate?

Yes

No

I don't know

# What have we learned??

- The frog study published in 2005 proved that the soapy additive in Roundup is toxic to frogs...we've known that for 40 years.
- Seralini's work with cancer in rats was found to be flawed and the publishing journal retracted the paper.
- WHO has not provided new data that glyphosate is a probable carcinogen. No other domestic or international organization share the WHO position.

So where are we?



Glyphosate is good for me-e-e!

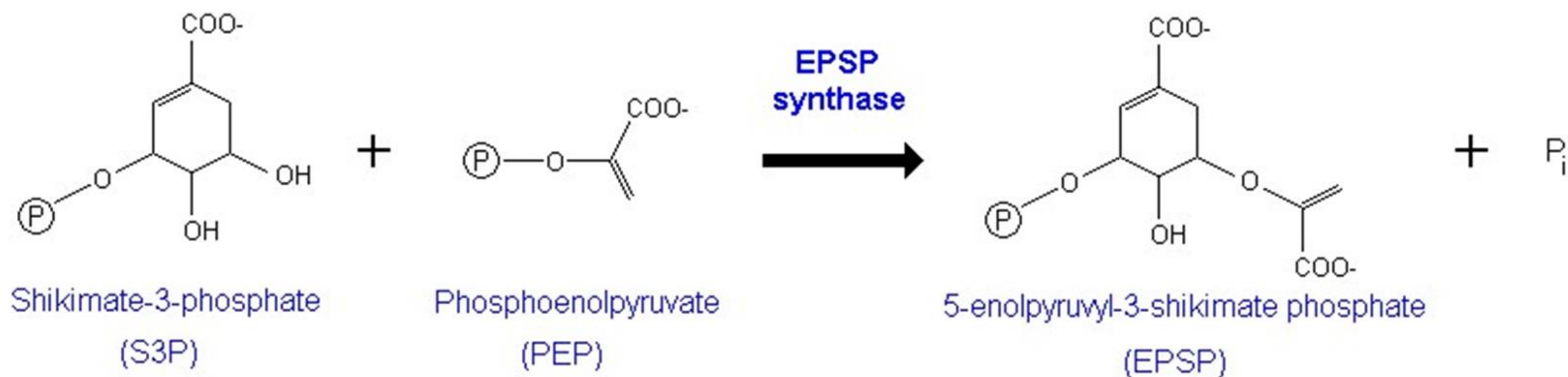
**THE DANGERS OF  
GLYPHOSATE**

# Glyphosate works by blocking amino acid production

- Amino acids are essential building blocks for growth and function
- unlike animals, plants make their own
- amino acids are the primary components of proteins and nucleic acids

# How do they work?

- Block a specific enzyme





# How do they work?

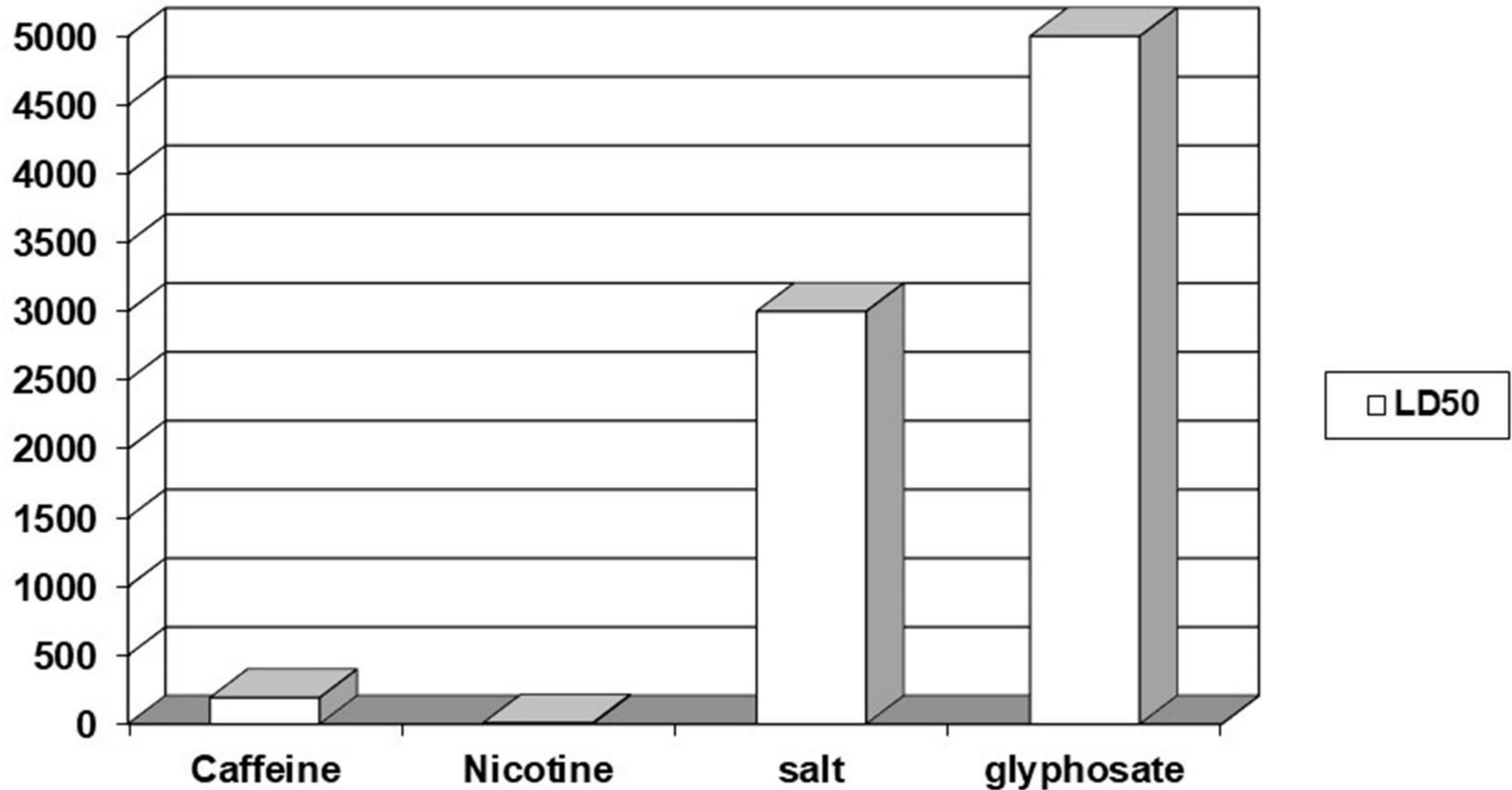
- When you block these enzymes, nothing can get through to the next step.



# Glyphosate

- All plants have EPSP enzymes
- Humans do not

# Glyphosate toxicity



\*The smaller the number, the greater the toxicity

# Why is glyphosate not harmful to humans?

- There is no EPSP enzyme in our bodies
- The herbicide has nowhere to bind
- It flushes out in urine
  
- However, it is important to wear your PPE
  - There are soaps and other materials in the jug that can cause eye irritation and so on.

# Is glyphosate good or bad?

- Neither

A better question is this:  
Is glyphosate harmful?

- If used correctly, it poses a very low risk to humans or the environment

Do

- Th

