



*Rosario
Argentina*

Glyphosate and Roundup: Scientific evidence of adverse impact on health and the environment

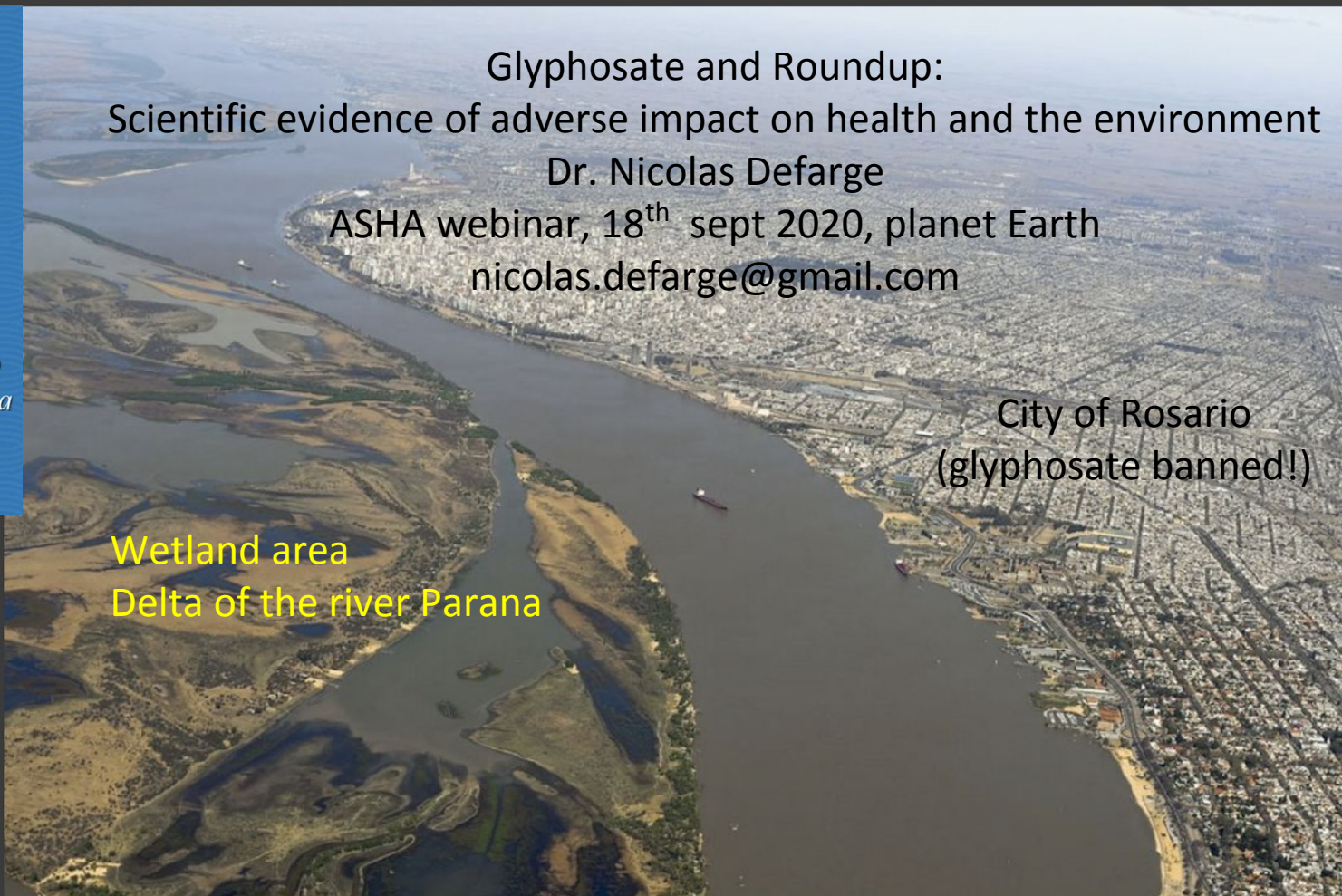
Dr. Nicolas Defarge

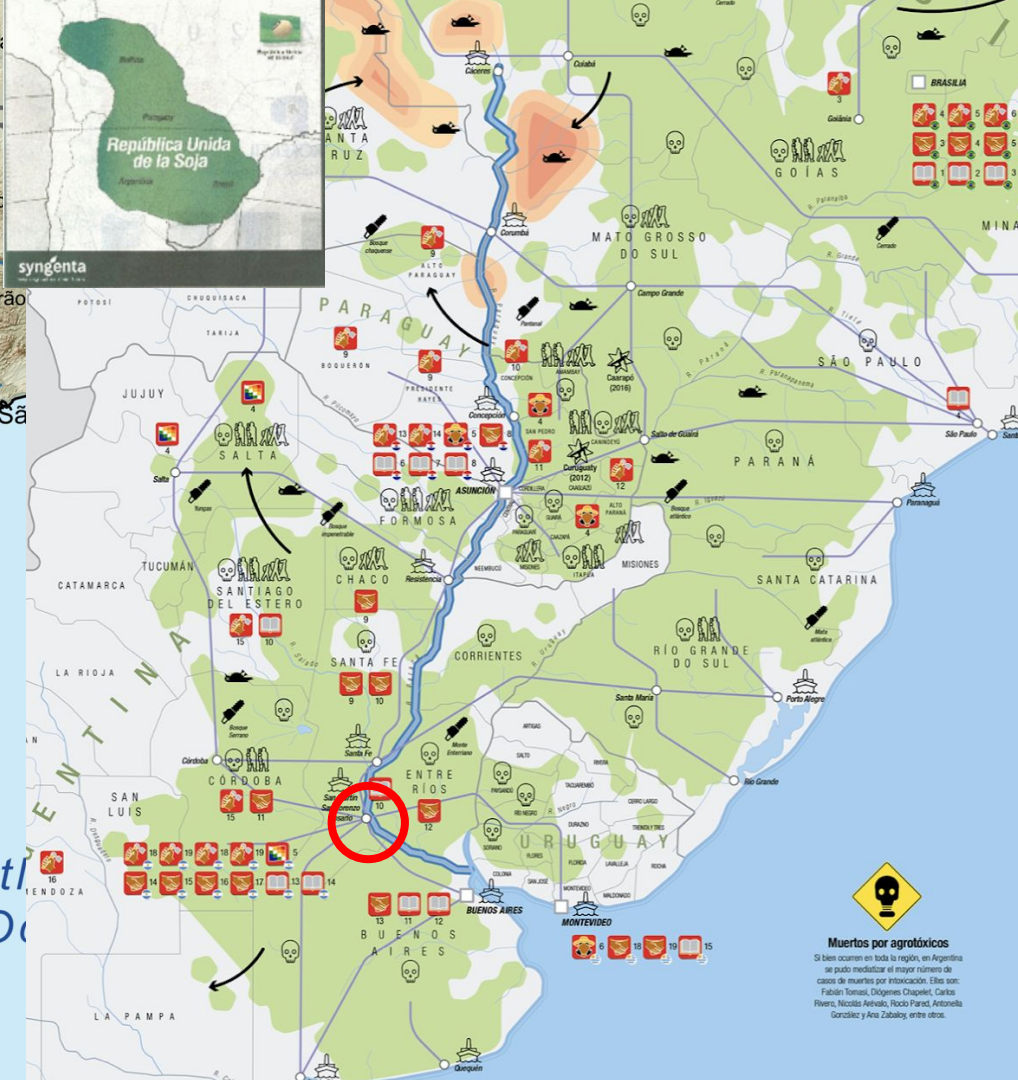
ASHA webinar, 18th sept 2020, planet Earth

nicolas.defarge@gmail.com

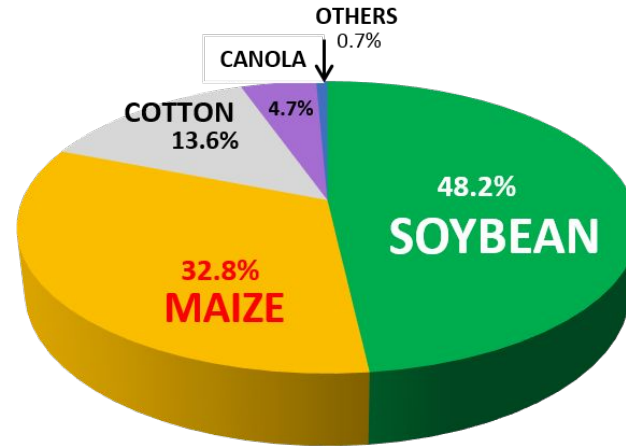
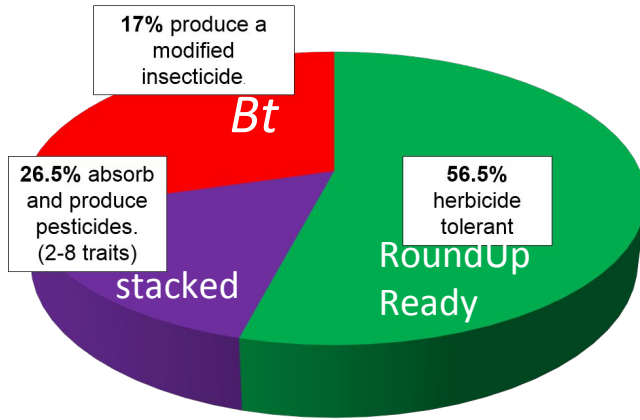
Wetland area
Delta of the river Parana

City of Rosario
(glyphosate banned!)

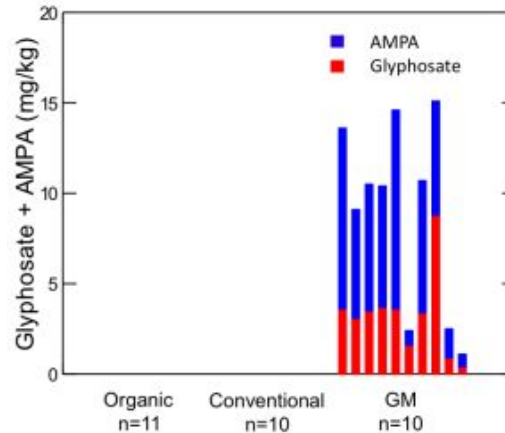




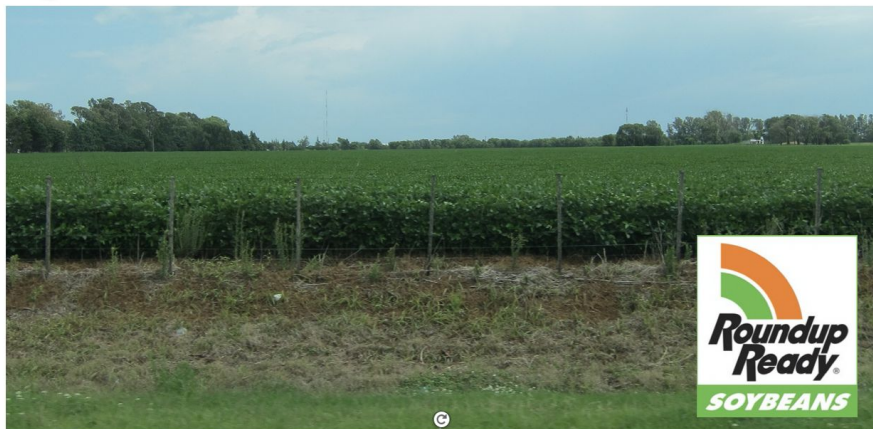
80% of GMOs are tolerant to herbicide(s), mostly to glyphosate



ISAAA
2017



Soybeans from
Brazil
Bohn et al., 2014



Harbour for loading of soja flour, few km upstream of Rosario
(market of 9 billions US Dollars, mostly exported to China),

Water quality of the main tributaries of the Paraná Basin: glyphosate and AMPA in surface water and bottom sediments

A. E. Ronco , D. J. G. Marino, M. Abelando, P. Almada & C. D. Apartin 

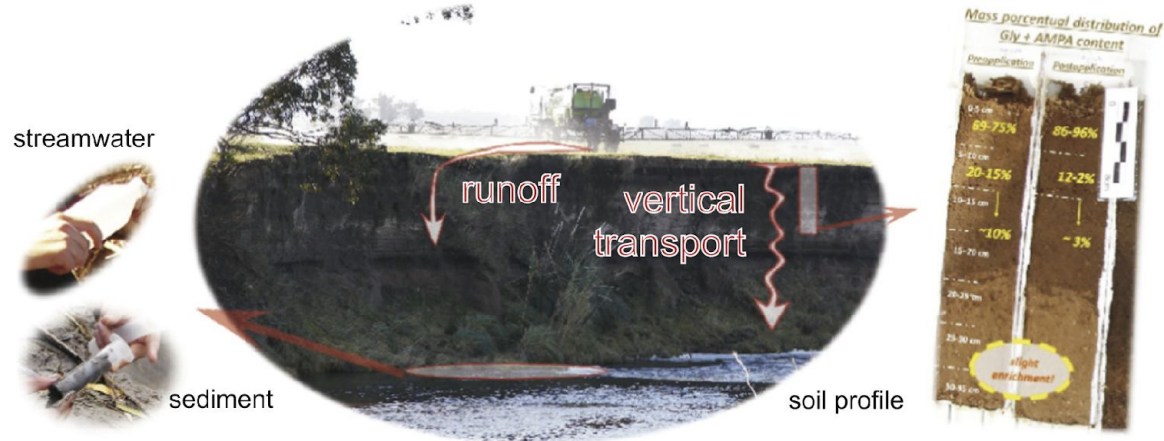
Environmental Monitoring and Assessment **188**, Article number: 458 (2016) | [Cite this article](#)

Occurrence of glyphosate and AMPA in an agricultural watershed from the southeastern region of Argentina

Leonardo Lupi ^a, Karina S.B. Miglioranza ^{a,*}, Virginia C. Aparicio ^b, Damian Marino ^c, Francisco Bedmar ^b, Daniel A. Wunderlin ^d



GRAPHICAL ABSTRACT



Re-registration Challenges of Glyphosate in the European Union

REVIEW

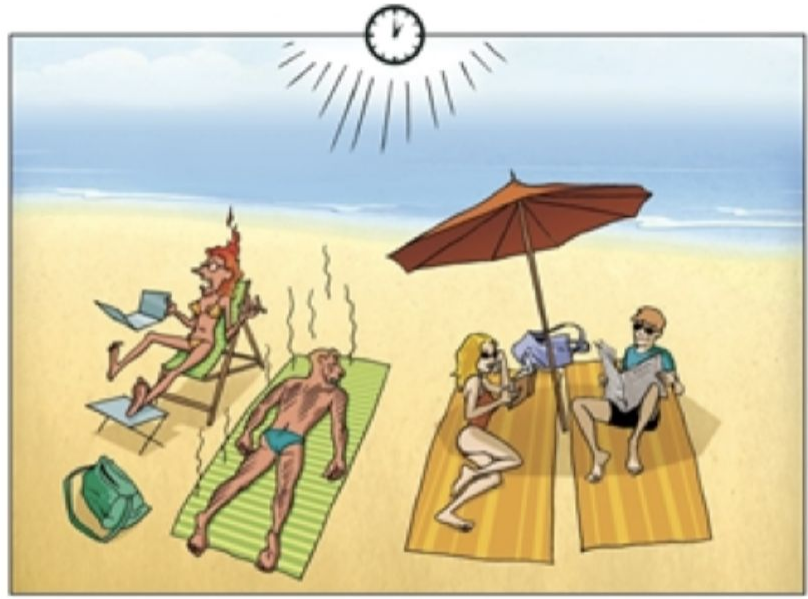
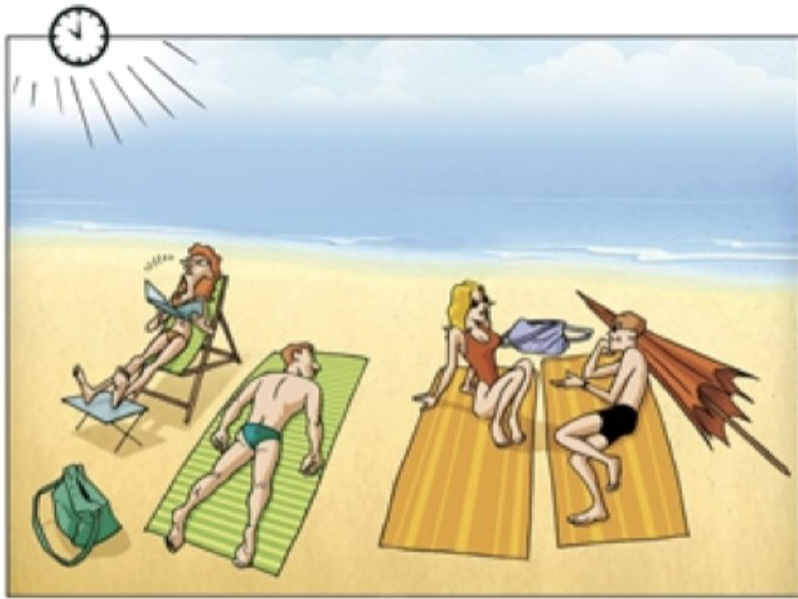
published: 31 July 2018

doi:

10.3389/fenvs.2018.00078

András Székács^{1} and Béla Darvas²*

SOUTH AMERICA				
Argentina (Buenos Aires Province)	100–700	Flow increased by rain caused the transport of the herbicide from the direct area of influence to downstream sites	2004	Peruzzo et al., 2008
Argentina (Buenos Aires Province)	Glyphosate: up to 298 AMPA: up to 235	Glyphosate and AMPA are present in the soil of the agricultural basin (35–1502 and 299–2256 $\mu\text{g/kg}$, respectively), and reach surface water via surface run-off of soil particles	2012	Aparicio et al., 2013
Argentina (Buenos Aires Province)	Glyphosate: up to 258 (in 69% of samples) AMPA: up to 5865 (in 69% of samples)	Surface stream, ground water sampled; the sampling site under urban-industrial land use had high concentrations in the spring (attributed to point pollution),	2010–2013	Caprile et al., 2017
Argentina (Formosa, Chaco, Santa Fé, Buenos Aires, Entre Rios Provinces)	Glyphosate: 0.2–1.8 (Galeguay River) up to 0.7 (in 15% of samples) (Paraná River) AMPA: 0.1–1.9 (Galeguay River) <0.3 (Paraná River)	Higher levels in the middle- and lower-course tributaries of Paraná River in accordance with the intensive agriculture in those regions; pollutant adsorption on suspended matter	2011–2012	Ronco et al., 2016
Argentina (Buenos Aires Province)	Glyphosate and AMPA: up to 0.5 (in 33 and 20% of samples, respectively) (Quequén Grande River)	Glyphosate and AMPA were registered in almost all matrices at different sampling times (pre- and post-application events).	2012–2013	Lupi et al., 2015
Argentina (Buenos Aires Province)	Glyphosate: up to 18.5 (in 78.9% of samples) AMPA: up to 47.5 (in 96.5% of samples)	Glyphosate and AMPA predominated in surface water and sediment samples in the El Crespo stream	2014–2015	Pérez et al., 2017
Argentina (Buenos Aires Province)	Glyphosate: up to 4.5 (in >40% of samples) AMPA: up to 0.9	In shallow lakes in the Pampa region	2015	Castro Berman et al., 2018
Brazil (Rio de Janeiro region)	Glyphosate: 2.6–10.1, AMPA < 0.1 (LOD) in surface water glyphosate < 0.35 (LOD), AMPA < 0.1 (LOD) in ground water	Surface and ground water used for irrigation from the region of Rio de Janeiro tested	2017	Pinto et al., 2018



RISK = HAZARD x EXPOSURE

Exposure is high! (in almost everybody's urine, Niemann et al., 2015):
First pesticide active ingredient worldwide: 800 000 tons/year (Zhang et al., 2019)
Regulatory « safety » thresholds 1000x higher than any other pesticide
(e.g. US MRL: 400 ppm /alfalfa vs 0.1 ppm for any other a.i)

Exposure is the highest for GM fields workers...

- epidemiology: genotoxicity (DNA damage and chromosomal aberrations in soybeans workers:

Brazil (Rio Grande do Sul, Benedetti et al., 2013)

Argentina (Manas et al., 2009)

Ecuador (Paz-y-Mino, 2007)

Exposure is high for the sprayed villages (pueblos fumigados)



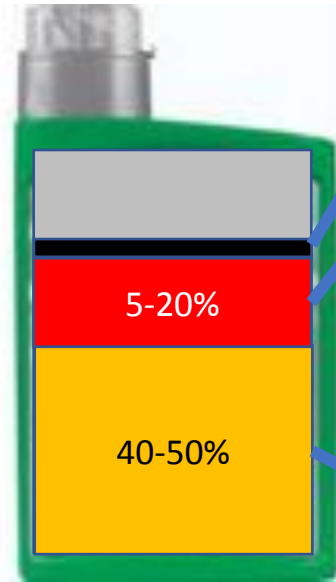
- epidemiology: sanitary camps in Argentina (pueblos fumigados)

a impressive survey by Dr. Verzenassi et al. involving over 100.000 people (to be published)

Cancers, miscarriages (spontaneous abortions), malformations were investigated.

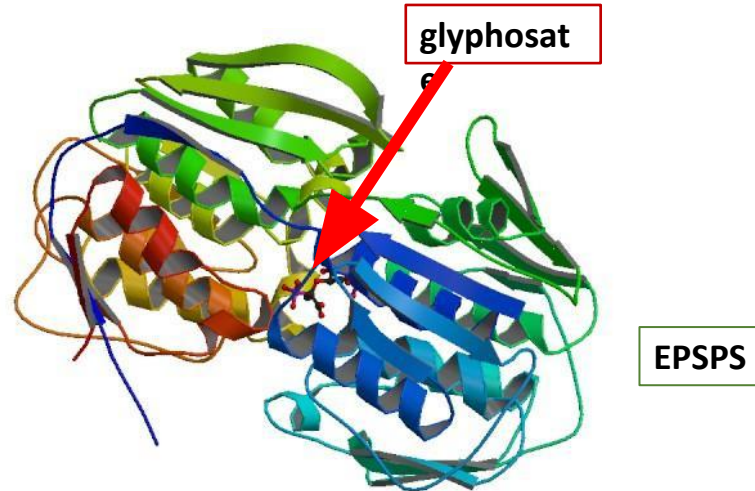
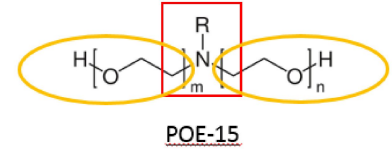
Roundup formulation

Main pesticide in the world



Contaminants: 1,4-dioxane, formaldehyde, arsenic (Defarge et al., 2018): known carcinogenic

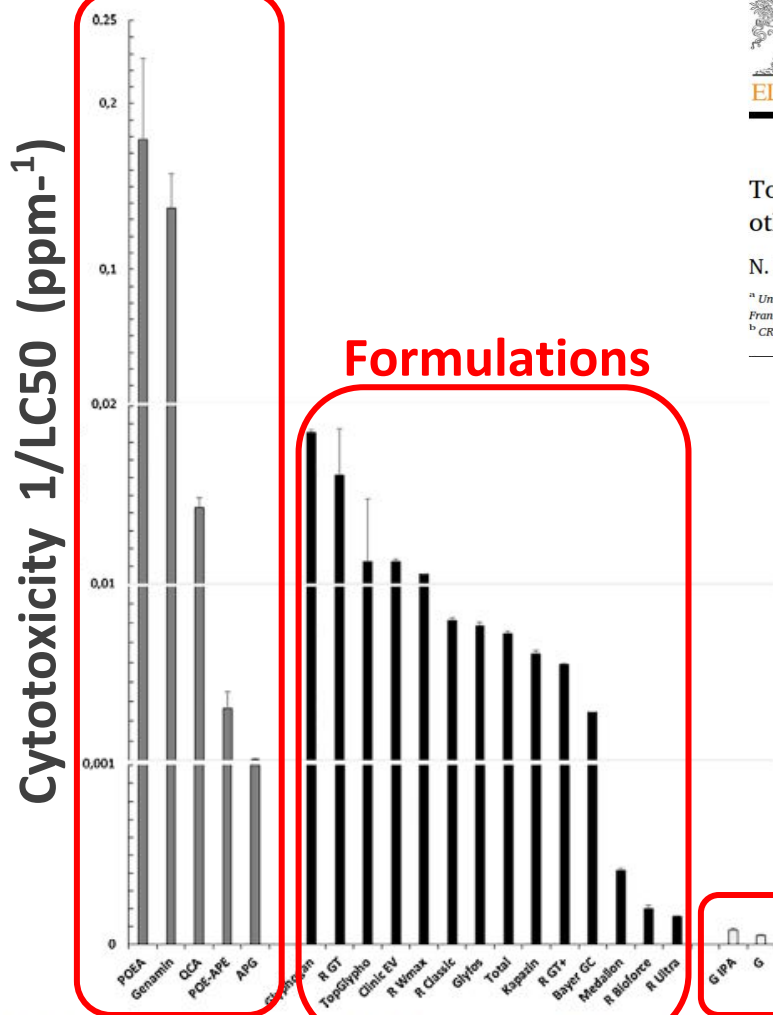
Co-Formulants: « Inerts »
Confidential and some being highly toxic (POEA)



A declared active ingredient: Glyphosate,
inhibitor of the plant/bacterial enzyme
EPSPS

Glyphosate only is assessed for chronic toxicity for regulatory purposes!

Co-formulants



Formulations

Glyphosate alone



Contents lists available at [ScienceDirect](http://www.sciencedirect.com)

Toxicology Reports

journal homepage: www.elsevier.com/locate/toxrep



Toxicity of formulants and heavy metals in glyphosate-based herbicides and other pesticides

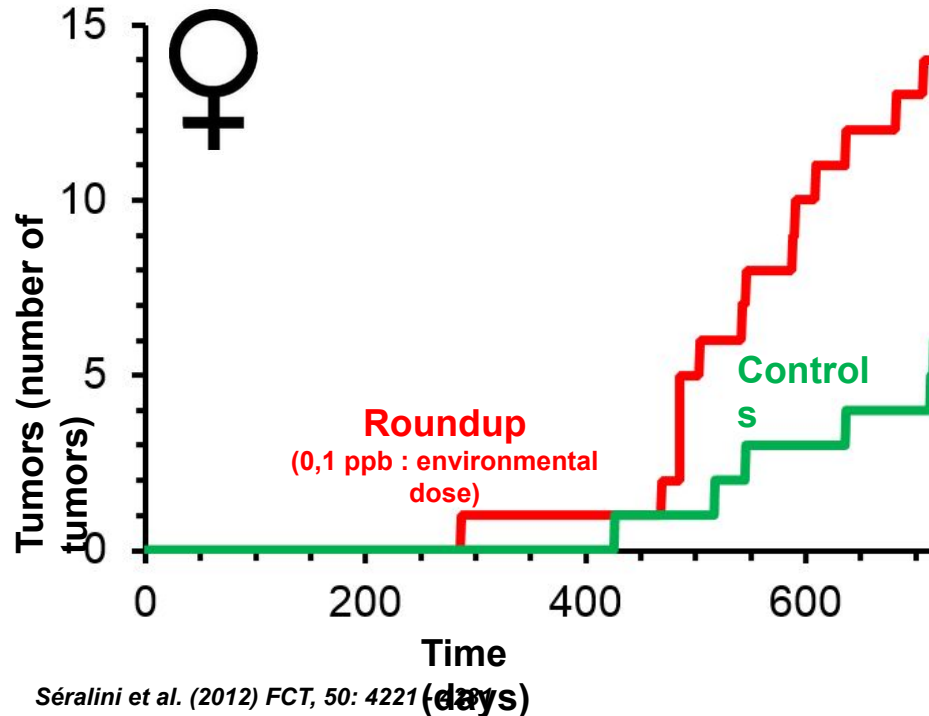
N. Defarge^a, J. Spiroux de Vendômois^b, G.E. Seralini^{a,*}

^a University of Caen Normandy, Department of Biology and Network on Risks, Quality and Sustainable Environment MRSH, Esplanade de la Paix, 14032 Caen Cedex, France

^b CRIIGEN, 81 Rue Monceau, 75008 Paris, France



We performed the only existing study investigating the chronic effects of a pesticide formulation ! (and not the only declared active ingredient)



RESEARCH

Open Access

Republished study: long-term toxicity of a Roundup herbicide and a Roundup-tolerant genetically modified maize

Gilles-Eric Séralini^{1*}, Emilie Clair¹, Robin Mesnage¹, Steeve Gress¹, Nicolas Defarge¹, Manuela Malatesta², Didier Hennequin³ and Joël Spiroux de Vendômois¹





RESEARCH

Open Access



CrossMark

Transcriptome profile analysis reflects rat liver and kidney damage following chronic ultra-low dose Roundup exposure

Robin Mesnage¹, Matthew Arno², Manuela Costanzo³, Manuela Malatesta³, Gilles-Eric Seralini⁴ and Michael N. Antoniou^{1*}

www.nature.com/scientificreports

SCIENTIFIC REPORTS

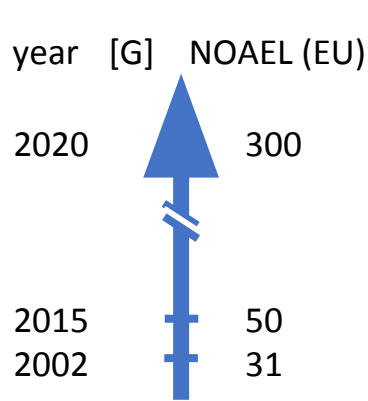
OPEN

Multomics reveal non-alcoholic fatty liver disease in rats following chronic exposure to an ultra-low dose of Roundup herbicide

Received: 22 July 2016
Accepted: 22 November 2016
Published: 09 January 2017

Robin Mesnage¹, George Renney², Gilles-Eric Seralini³, Malcolm Ward² & Michael N. Antoniou¹

Health effects of Glyphosate and Roundup: Regulatory "Science"



The EU current **NOAEL (No Observed Adverse Effect Level)**= 50 mg/kg/d (in lab mammals –rats, mice, rabbits-).

The **ADI (Acceptable Daily Intake)** is the NOAEL divided by 100.

It was 31 before 2015, the GlyphosateTask Force (2020) proposes 300 mg/kg/d

-> Is glyphosate getting safer?

-> Or are experts getting blinder so that they can no longer observe adverse effects they used to?

Adverse effects below regulatory « safe » levels are documented!



Contents lists available at [ScienceDirect](#)

Food and Chemical Toxicology

journal homepage: www.elsevier.com/locate/foodchemtox



Review

Potential toxic effects of glyphosate and its commercial formulations below regulatory limits

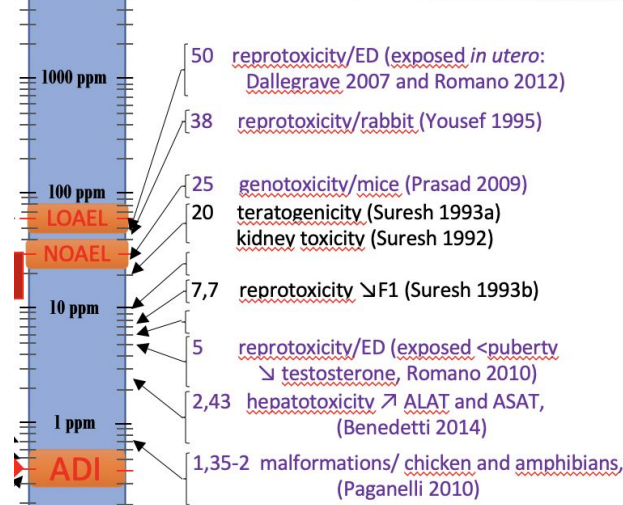
R. Mesnage ^{a, b, 1}, N. Defarge ^{a, b}, J. Spiroux de Vendômois ^b, G.E. Séralini ^{a, b, *}

^a University of Caen, Institute of Biology and Network on Risks, Quality and Sustainable Environment (MRSH), Esplanade de la Paix, 14032 Caen Cedex, France

^b CRIIGEN, 81 rue de Monceau, 75008 Paris, France



Effects observed *in vivo*
under the LOAEL
and even the NOAEL
(on rat, otherwise indicated)



**Adverse effects below the
regulatory NO Adverse Effect
Level are documented!**

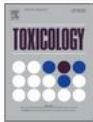
{ 2,5-4,6.10⁻⁶ R (A) (Séralini 2014) liver and kidney toxicity, sex hormone imbalance
 \nearrow mortality, (F), mammary fibroadenomas, pituitary adenomas (F)

Health effects of Glyphosate and Roundup: endocrine disruption



Toxicology

Volume 376, 1 February 2017, Pages 2-14



Neonatal exposure to a glyphosate based herbicide alters the development of the rat uterus

Marlise Guerrero Schimpf, María M. Milesi, Paola I. Ingaramo, Enrique H. Luque, Jorgelina Varayoud

Show more

<https://doi.org/10.1016/j.tox.2016.06.004>

[Get rights and content](#)

Highlights

- Neonatal exposure to GBH lead to endometrial hyperplasia and increase proliferation.
- GBH disrupts proteins involved in uterine organogenetic differentiation.
- GBH exposure induced persistent increase of PR and Hoxa10 proteins.



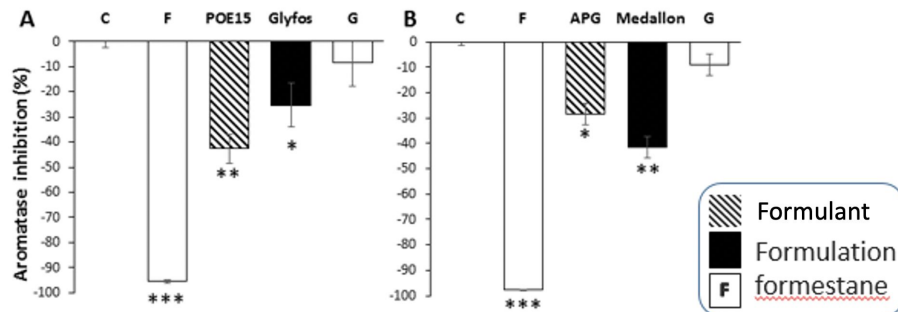
International Journal of
Environmental Research
and Public Health



Article

Co-Formulants in Glyphosate-Based Herbicides Disrupt Aromatase Activity in Human Cells below Toxic Levels

Nicolas Defarge ^{1,3}, Eszter Takács ², Verónica Laura Lozano ¹, Robin Mesnage ^{1,3}, Joël Spiroux de Vendômois ³, Gilles-Eric Seralini ^{1,3,*} and András Székács ²



Co-formulants alone exert ED effects

SCIENTIFIC REPORTS

Article | [Open Access](#) | Published: 23 April 2019

Assessment of Glyphosate Induced Epigenetic Transgenerational Inheritance of Pathologies and Sperm Epimutations: Generational Toxicology

Deepika Kubsad, Eric E. Nilsson, Stephanie E. King, Ingrid Sadler-Riggelman, Daniel Beck & Michael K. Skinner 

Scientific Reports **9**, Article number: 6372 (2019) | [Cite this article](#)

44k Accesses | **6** Citations | **1666** Altmetric | [Metrics](#)

Abstract

Ancestral environmental exposures to a variety of factors and toxicants have been shown to promote the epigenetic transgenerational inheritance of adult onset disease. One of the most widely used agricultural pesticides worldwide is the herbicide glyphosate (N-(phosphonomethyl)glycine), commonly known as Roundup. There are an increasing number of conflicting reports regarding the direct exposure toxicity (risk) of glyphosate, but no rigorous investigations on the generational actions. The current study using a transient exposure of gestating F0 generation female rats found negligible impacts of glyphosate on the directly exposed F0 generation, or F1 generation offspring pathology. In contrast, dramatic increases in pathologies in the F2 generation grand-offspring, and F3 transgenerational great-grand-offspring were observed. The transgenerational pathologies observed include prostate disease, obesity, kidney disease, ovarian disease, and parturition (birth) abnormalities. Epigenetic analysis of the F1, F2 and F3 generation sperm identified differential DNA methylation regions (DMRs). A number of DMR associated genes were identified and previously shown to be involved in pathologies. Therefore, we propose glyphosate can induce the transgenerational inheritance of disease and germline (e.g. sperm) epimutations. Observations suggest the generational toxicology of glyphosate needs to be considered in the disease etiology of future generations.

Glyphosate Primes Mammary Cells for Tumorigenesis by Reprogramming the Epigenome in a TET3-Dependent Manner

 Manon Dufourest^{1,2,3,4†},  Arulraj Nadaradjane^{1,2,3,4†},  Gwenola Bougras-Cartron^{1,2,3,4†},  Joséphine Briand^{1,2,3,4†},  Christophe Olivier^{1,2,5},  Jean-Sébastien Frenel^{1,2,3,4†},  François M. Vallette^{1,2,3,4†},  Sophie A. Lelièvre^{6,7} and  Pierre-François Cartron^{1,2,3,4†}

¹CRCINA, INSERM, Université de Nantes, Nantes, France

²Equipe Apoptose et Progression tumorale, LaBCT, Institut de Cancérologie de l'Ouest, Saint Herblain, France

³Cancéropole Grand-Ouest, réseau Epigénétique (RepiCGO), Nantes, France

⁴LabEX IGO, Université de Nantes, Nantes, France

⁵Service de toxicologie, Faculté de pharmacie de Nantes, Nantes, France

⁶Department of Basic Medical Sciences, Purdue University, West Lafayette, IN, United States

⁷Purdue University Center for Cancer Research, West Lafayette, IN, United States



Epigenomics and Epigenetics

Front. Genet., 27 September 2019

The acknowledgment that pollutants might influence the epigenome raises serious concerns regarding their long-term impact on the development of chronic diseases. The herbicide glyphosate has been scrutinized for an impact on cancer incidence, but reports demonstrate the difficulty of linking estimates of exposure and response analysis. An approach to better apprehend a potential risk impact for cancer is to follow a synergistic approach, as cancer rarely occurs in response to one risk factor. The known influence of glyphosate on estrogen-regulated pathway makes it a logical target of investigation in breast cancer research. We have used nonneoplastic MCF10A cells in a repeated glyphosate exposure pattern over 21 days. Glyphosate triggered a significant reduction in DNA methylation, as shown by the level of 5-methylcytosine DNA; however, in contrast to strong demethylating agent and cancer promoter UP peptide, glyphosate-treated cells did not lead to tumor development. Whereas UP acts through a DNMT1/PCNA/UHRF1 pathway, glyphosate triggered increased activity of ten-eleven translocation (TET)3. Combining glyphosate with enhanced expression of microRNA (miR) 182-5p associated with breast cancer induced tumor development in 50% of mice. Culture of primary cells from resected tumors revealed a luminal B (ER+/PR-/HER2-) phenotype in response to glyphosate-miR182-5p exposure with sensitivity to tamoxifen and invasive and migratory potentials. Tumor development could be prevented either by specifically inhibiting miR 182-5p or by treating glyphosate-miR 182-5p-cells with dimethylallyl glycine, an inhibitor of TET pathway. Looking for potential epigenetic marks of TET-mediated gene regulation under glyphosate exposure, we identified *MTRNR2L2* and *DUX4* genes, the hypomethylation of which was sustained even after stopping glyphosate exposure for 6 weeks. Our findings reveal that low pressure but sustained DNA hypomethylation occurring via the TET pathway primes cells for oncogenic response in the presence of another potential risk factor. These results warrant further investigation of glyphosate-mediated breast cancer risk.

Health effects of Glyphosate and Roundup on the rodent gut microbiota



Toxicology Reports

Volume 5, 2018, Pages 96-107



Sex-dependent impact of Roundup on the rat gut microbiome

Veronica L. Lozano ^{a, f}, Nicolas Defarge ^{a, f}, Louis-Marie Rocque ^{a, f}, Robin Mesnage ^{a, f}, Didier Hennequin ^a, Renaud Cassier ^a, Joël Spiroux de Vendômois ^a, Jean-Michel Panoff ^{a, c, e, f}, Gilles-Eric Seralini ^{a, c, f}, Caroline Amiel ^{a, c, f}  

 [Show more](#)

<https://doi.org/10.1016/j.toxrep.2017.12.005>

[Get rights and content](#)

Under a Creative Commons license

[open access](#)

Highlights

- We have examined the long-term effects of Roundup on rat gut [microbiota](#).
- 141 bacteria families were identified by a high-throughput sequencing approach.
- Roundup caused an alteration of the [Firmicutes](#) to [Bacteroidetes](#) ratio.
- An environmental concentration of Roundup has a sex-dependent impact on rat gut [microbiome](#).



Neurotoxicology and Teratology

Volume 67, May–June 2018, Pages 44–49



Brief communication

Glyphosate based- herbicide exposure affects gut microbiota, anxiety and depression-like behaviors in mice

Yassine Aitbali ^a, Saadia Ba-M'hamed ^a, Najoua Elhida ^a, Ahmed Nafis ^b, Nabila Soraa ^c, Mohamed Bennis ^a  

 [Show more](#)

<https://doi.org/10.1016/j.ntt.2018.04.002>

[Get rights and content](#)

Highlights

- Toxic effects of Glyphosate-based herbicide on mice gut microbiota and neurobehavior were investigated.
- Glyphosate-based herbicide exposure leads to despair behavior.
- Glyphosate-based herbicide changed the gut microbiota abundance and composition.

Adverse effects of Glyphosate and Roundup on the environment



insects

Open Access Review

Effects of the Herbicide Glyphosate on Honey Bee Sensory and Cognitive Abilities: Individual Impairments with Implications for the Hive

by Walter M. Farina^{1,2,*}, M. Sol Balbuena^{1,2}, Lucila T. Herbert^{1,2},
Carolina Mengoni Goñalons^{1,2} and Diego E. Vázquez^{1,2}

¹ Laboratorio de Insectos Sociales, Departamento de Biodiversidad y Biología Experimental, Facultad de Ciencias Exactas y Naturales, Universidad de Buenos Aires, Buenos Aires 1428, Argentina

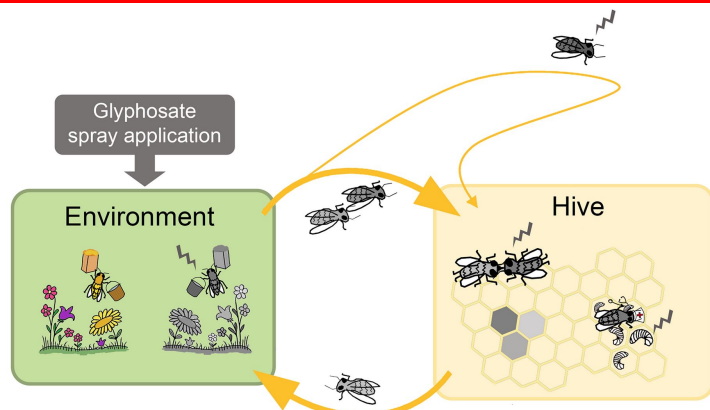
² Biología Molecular y Neurociencias (IFIBYNE), Instituto de Fisiología, CONICET-Universidad de Buenos Aires, Buenos Aires 1428, Argentina

* Author to whom correspondence should be addressed.

Insects **2019**, *10*(10), 354; <https://doi.org/10.3390/insects10100354>

Received: 21 September 2019 / Accepted: 14 October 2019 / Published: 18 October 2019

effects can be detected using experimental approaches. GLY negatively affects associative learning processes of foragers, cognitive and sensory abilities of young hive bees and promotes delays in brood development. An integrated approach that



Glyphosate perturbs the gut microbiota of honey bees

Erick V. S. Motta, Kasie Raymann, and Nancy A. Moran



Abstract

Glyphosate, the primary herbicide used globally for weed control, targets the 5-enolpyruvylshikimate-3-phosphate synthase (EPSPS) enzyme in the shikimate pathway found in plants and some microorganisms. Thus, glyphosate may affect bacterial symbionts of animals living near agricultural sites, including pollinators such as bees. The honey bee gut microbiota is dominated by eight bacterial species that promote weight gain and reduce pathogen susceptibility. The gene encoding EPSPS is present in almost all sequenced genomes of bee gut bacteria, indicating that they are potentially susceptible to glyphosate. We demonstrated that the relative and absolute abundances of dominant gut microbiota species are decreased in bees exposed to glyphosate at concentrations documented in the environment. Glyphosate exposure of young workers increased mortality of bees subsequently exposed to the opportunistic pathogen *Serratia marcescens*. Members of the bee gut microbiota varied in susceptibility to glyphosate, largely corresponding to whether they possessed an EPSPS of class I (sensitive to glyphosate) or class II (insensitive to glyphosate). This basis for differences in sensitivity was confirmed using *in vitro* experiments in which the EPSPS gene from bee gut bacteria was cloned into *Escherichia coli*. All strains of the core bee gut species, *Snodgrassella alvi*, encode a sensitive class I EPSPS, and reduction in *S. alvi* levels was a consistent experimental result. However, some *S. alvi* strains appear to possess an alternative mechanism of glyphosate resistance. Thus, exposure of bees to glyphosate can perturb their beneficial gut microbiota, potentially affecting bee health and their effectiveness as pollinators.

Adverse effects of Glyphosate and Roundup on the environment

> [Sci Rep](#). 2015 Aug 5;5:12886. doi: 10.1038/srep12886.

Glyphosate-based herbicides reduce the activity and reproduction of earthworms and lead to increased soil nutrient concentrations

Mailin Gaupp-Berghausen ¹, Martin Hofer ², Boris Rewald ², Johann G Zaller ¹

Research Article | Published: 11 April 2016

Multiple effects of a commercial Roundup® formulation on the soil filamentous fungus *Aspergillus nidulans* at low doses: evidence of an unexpected impact on energetic metabolism

[Valérie Nicolas](#), [Nathalie Oestreicher](#) & [Christian Vélot](#) ✉

Published: March 2003

Induction of Mortality and Malformation in *Scinax nasicus* Tadpoles Exposed to Glyphosate Formulations

[R. C. Lajmanovich](#), [M. T. Sandoval](#) & [P. M. Peltzer](#)

[Bulletin of Environmental Contamination and Toxicology](#) **70**, 0612–0618(2003) | [Cite this article](#)

550 Accesses | 80 Citations | 1 Altmetric | [Metrics](#)



[Heliyon](#). 2019 Oct; 5(10): e02601.

Published online 2019 Oct 25. doi: [10.1016/j.heliyon.2019.e02601](#)

PMCID: PMC6820099

PMID: [31687490](#)

First evaluation of novel potential synergistic effects of glyphosate and arsenic mixture on *Rhinella arenarum* (Anura: Bufonidae) tadpoles

[Rafael C. Lajmanovich](#)^{a,d,*}, [Paola M. Peltzer](#)^{a,d}, [Andrés M. Attademo](#)^{a,d}, [Candela S. Martinuzzi](#)^{a,d},
[María F. Simoniello](#)^b, [Carlina L. Colussi](#)^a, [Ana P. Cuzziol Boccioni](#)^{a,d} and [Mirna Sigris](#)^c



Article

Arthropod decline in grasslands and forests is associated with landscape-level drivers

<https://doi.org/10.1038/s41586-019-1684-3>

Received: 8 February 2019

Accepted: 16 September 2019

Published online: 30 October 2019

Sebastian Seibold^{1,2*}, Martin M. Gossner¹, Nadja K. Simons^{1,4}, Nico Blüthgen¹, Jörg Müller^{2,5}, Didem Ambarlı^{1,6}, Christian Ammer⁷, Jürgen Bauhus⁸, Markus Fischer⁹, Jan C. Habel^{1,10}, Karl Eduard Linsenmair¹¹, Thomas Nause¹², Caterina Penone¹³, Daniel Prati¹⁴, Peter Schall¹⁵, Ernst-Detlef Schulze¹⁶, Juliane Vogt¹, Stephan Wöllauer¹⁷ & Wolfgang W. Weisser¹

Recent reports of a decline in arthropod biodiversity in grasslands and forests across Europe and North America are linked to ornamental plants and 2017 at diversity in across sites number of consistent independent higher cover with annual by 41% and in three-year differed across arthropod. Arthropod. Our results and are (at implies the effects of la



frontiers
in Environmental Science

OPINION

published: 31 October 2019
doi: 10.3389/fenvs.2019.00177



Biodiversity Decline as a Consequence of an Inappropriate Environmental Risk Assessment of Pesticides

Carsten A. Brühl^{1*} and Johann G. Zaller²

¹ Community Ecology and Ecotoxicology, iES Landau, Institute for Environmental Sciences, University of Koblenz-Landau, Landau, Germany, ² Department of Integrative Biology and Biodiversity Research, Institute of Zoology, University of Natural Resources and Life Sciences (BOKU), Vienna, Austria

Keywords: ecotoxicology, plant protection products, agroecology, regulatory, EU

thanks for your attention!

nicolas.defarge@gmail.com



Contents lists available at [ScienceDirect](#)

Food and Chemical Toxicology

journal homepage: www.elsevier.com/locate/foodchemtox



Review

Potential toxic effects of glyphosate and its commercial formulations below regulatory limits

R. Mesnage^{a, b, 1}, N. Defarge^{a, b}, J. Spiroux de Vendômois^b, G.E. Seralini^{a, b, *}

^a University of Caen, Institute of Biology and Network on Risks, Quality and Sustainable Environment (MRSH), Esplanade de la Paix, 14032 Caen Cedex, France
^b CRIIIGEN, 81 rue de Monceau, 75008 Paris, France

ARTICLE INFO

Article history:
Received 7 April 2015
Received in revised form

ABSTRACT
Glyphosate-based herbicides (GlyBH), including Roundup, are the most widely used pesticides worldwide. Their uses have increased exponentially since their introduction on the market. Residue levels in



REVIEW
published: 31 July 2018
doi:
10.3389/fenvs.2018.00078



Re-registration Challenges of Glyphosate in the European Union

András Székács^{1*} and Béla Darvas²

¹ Agro-Environmental Research Institute, National Agricultural Research and Innovation Centre, Budapest, Hungary
² Hungarian Society of Ecotoxicology, Budapest, Hungary