Glyphosate's Negative Effects on the Ecosystem

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Outline

- Introduction
- Toxic Effects of Glyphosate
- Harm to the Ecosystem
- An Example: Florida Agriculture and Waterways
- Conclusion

Introduction

Roundup and GMO Crops

The amount of glyphosate used every year in the United States is equivalent to one pound for every man, woman and child

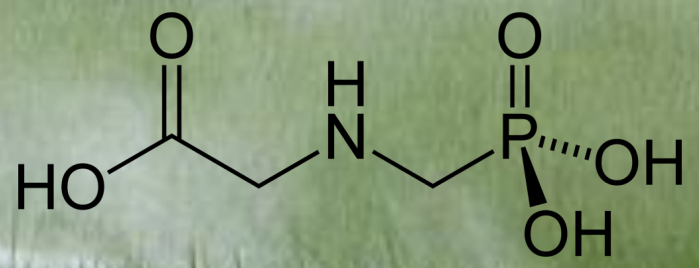
GMO Roundup-Ready corn, soy, canola, sugar beets
cotton, tobacco and alfalfa

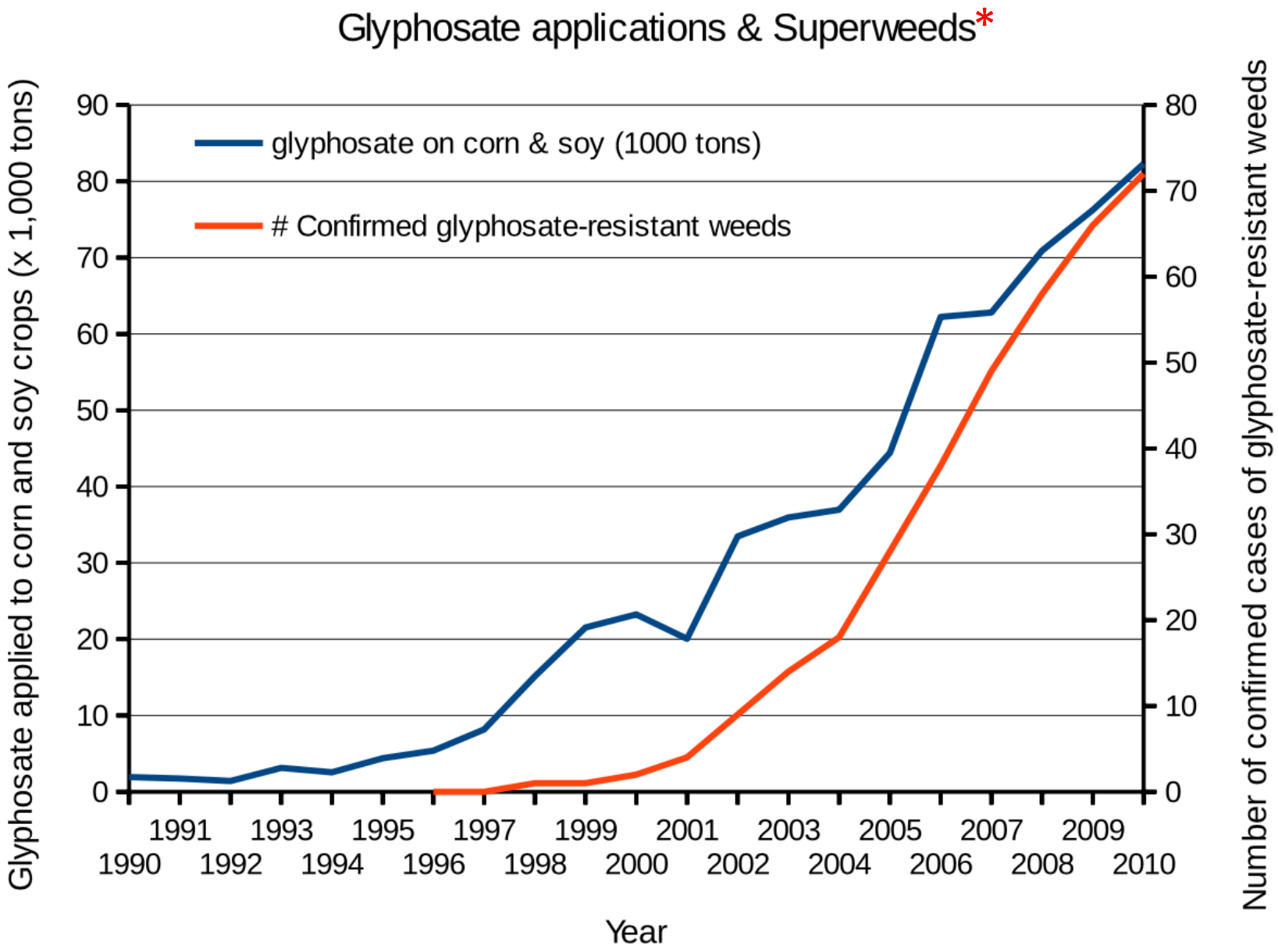
Roundup as a Desiccant/Ripener just before Harvest

Wheat, Oats, Barley, Rye, Sugar cane, Beans, Lentils, Peas, Flax, Sunflowers, Pulses, Chick Peas

A Brief History of Glyphosate

- Glyphosate is now the #1 herbicide in use in the U.S. and is increasingly used around the world
  - Patented by Monsanto as an herbicide in 1969
  - Introduced into the US food chain in 1974
  - Came out from under patent in 2000
  - Inhibits an enzyme in the *shikimate pathway* involved in synthesis of tyrosine, tryptophan and phenylalanine (the three *aromatic amino acids*)
- Huge expansion of GMO corn, soy, cotton and canola crops has led to sharp increases in the last two decades





Glyphosate usage increased dramatically over time, likely because of the emergence of glyphosate-resistant weeds

*Figure 1. Judy Hoy et al., Poultry, Fisheries & Wildlife Sciences 2015; 3(1): 1000132.

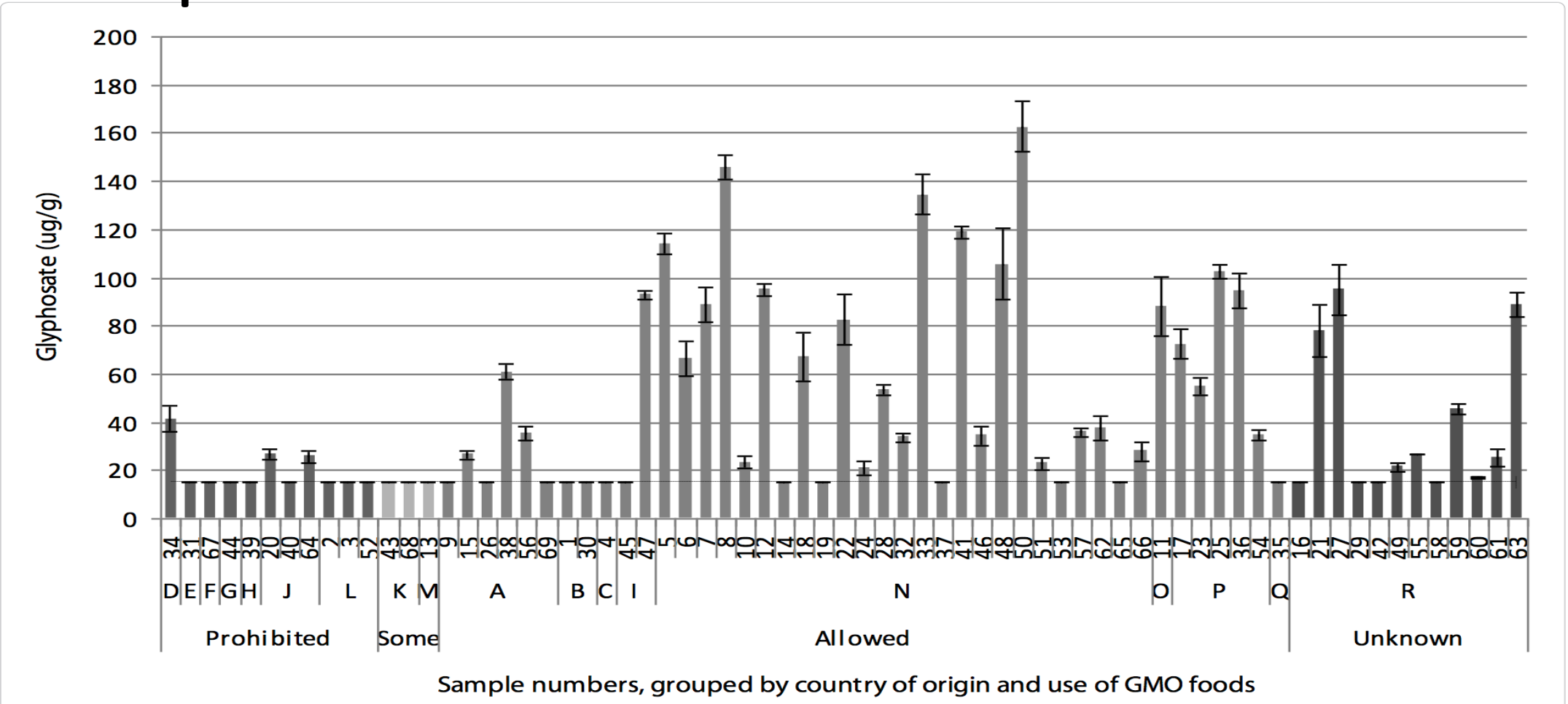
Superweeds Are Now a Huge Problem*

- 76.8% of samples submitted to a U of Illinois Plant Clinic from 10 states across the Midwest showed glyphosate resistance
- "GM crops are on the edge of failure in the U.S. as farmers are asked to fork out more and more money on herbicides to try to control the superweeds. We simply can't afford it! It is near the end of the road for these crops and many of my friends in the Midwest are on the edge of turning back to conventional farming methods."
  - Bill Giles, an Illinois farmer

*sustainablepulse.com/2017/02/04/farmers-losing-midwest-superweeds-fight-as-glyphosate-resistance-reaches-over-75/#

Some Foods Containing Glyphosate

Glyphosate was found in 59% of Honey Samples*



*F Rubio et al., J Environ Anal Toxicol 2014, 5:1

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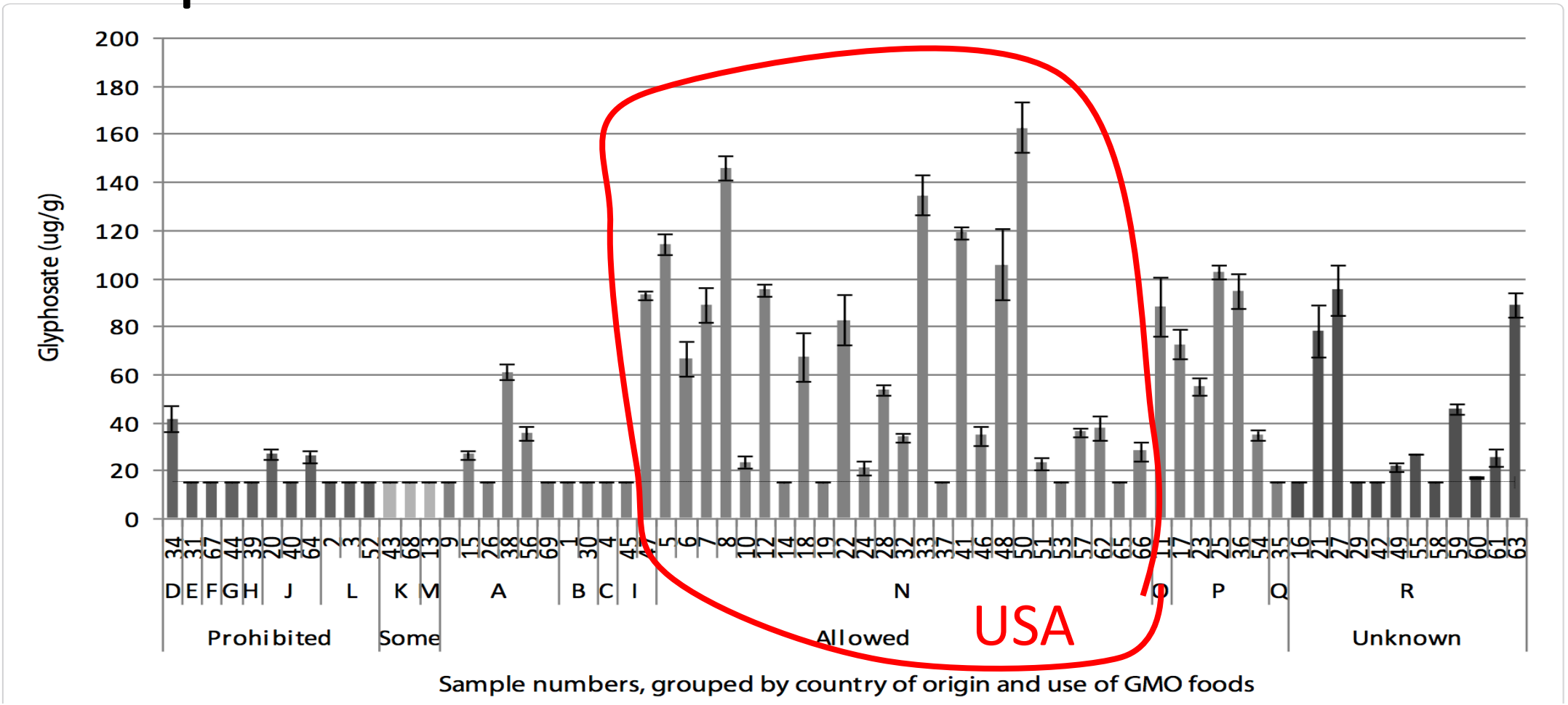


*F Rubio et al., J Environ Anal Toxicol 2014, 5:1

Toxic Effects of Glyphosate

Is Glyphosate Nontoxic?

- Monsanto has argued that glyphosate is harmless to humans because our cells don't have the shikimate biological pathway which is the pathway glyphosate disrupts to kill plants
- However, our gut bacteria DO have this pathway
  - We depend upon them to supply us with essential amino acids produced through that pathway, and with many other nutrients such as vitamins and short chain fatty acids
- Other ingredients in Roundup greatly increase glyphosate's toxic effects
- Insidious effects of glyphosate accumulate over time
  - Most studies are too short to detect damage
- Three successful US lawsuits claiming that glyphosate caused non-Hodgkin's lymphoma are bringing public awareness to glyphosate's toxicity
  - Tens of thousands of others are now following suit

Contents lists available at ScienceDirect

Neurotoxicology 2019; 75:1-8.

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

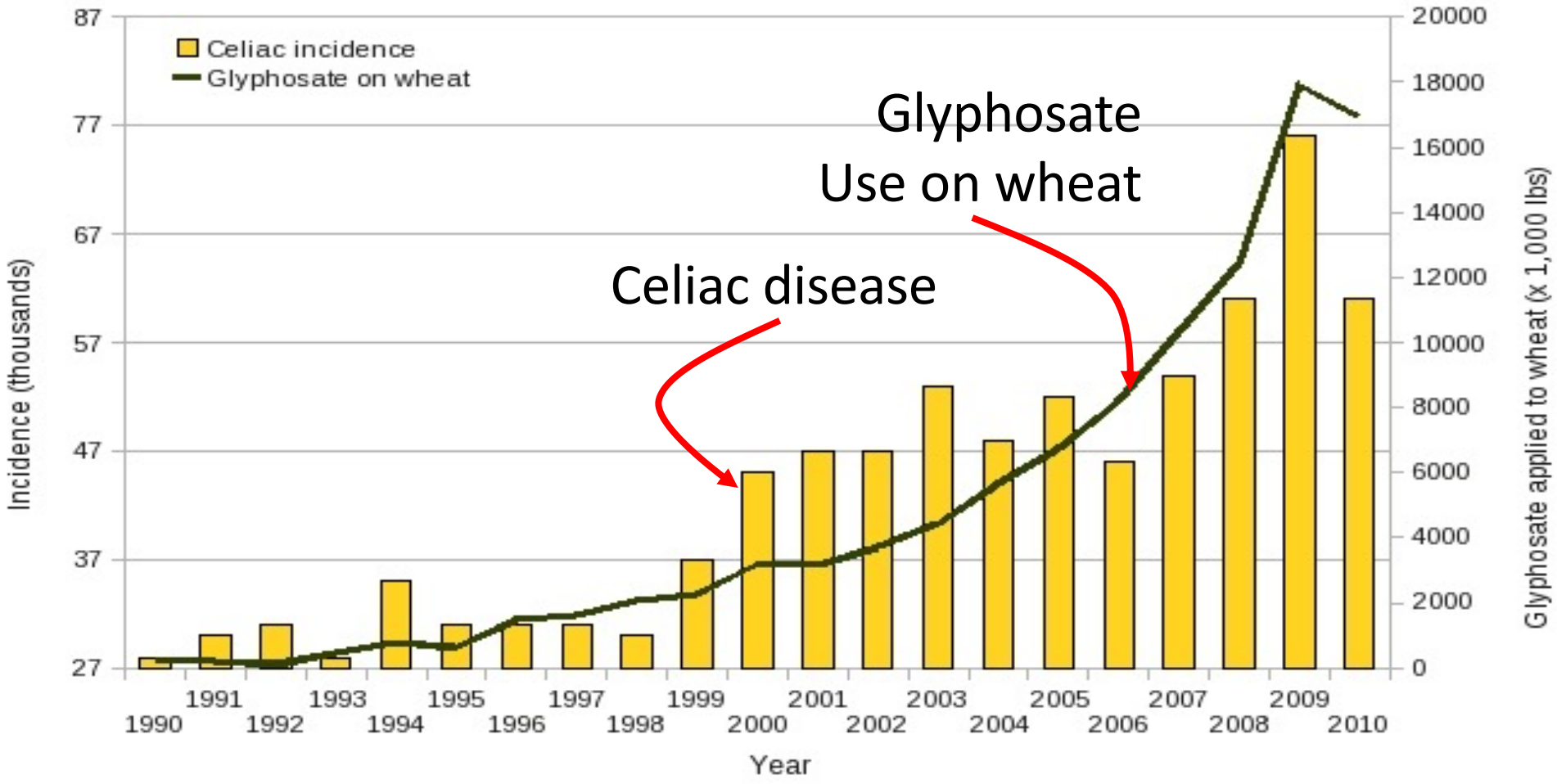
Full Length Article

Gut microbiota and neurological effects of glyphosate

Lola Rueda-Ruzafa[a], Francisco Cruz[b], Pablo Roman[c,d,e,*], Diana Cardona[c,e,f]

"In this work, we state a possible link between Gly[phosate]-induced *dysbiosis* and cognitive and motor aggravations in neurodegenerative and neurodevelopmental pathologies, such as autism spectrum disorder (ASD). Hence, we review the negative impact that Gly-induced dysbiosis may have on depression/anxiety, autism, Alzheimer's and Parkinson's diseases."

Glyphosate and Celiac Disease*



*A Samsel and S Seneff, Interdiscip Toxicol. 2013;**6**(4): 159–18

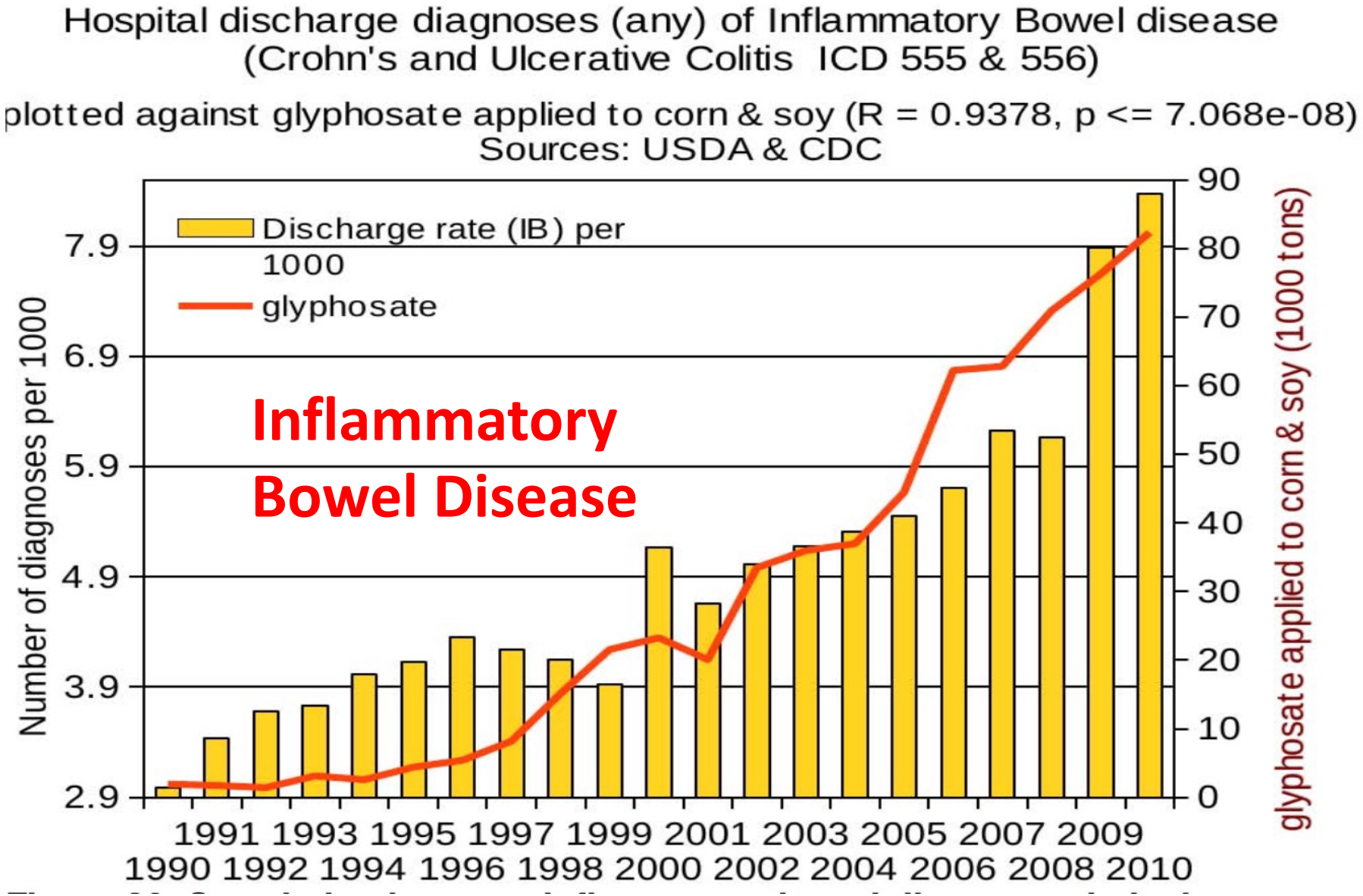


*Figure 20, NL Swanson et al. Journal of Organic Systems 9(2), 2014, p. 25.

Glyphosate Harm to the Ecosystem

Effect of Glyphosate on Water Flea Embryos*

- Water fleas are near the bottom of the aquatic food chain
- Tadpoles, salamanders, newts, aquatic insects and many types of small fish feed on water fleas
- When water fleas were exposed to concentrations of Roundup and glyphosate well below the approved regulatory threshold, they suffered from:
  - Embryonic developmental failure
  - Systemic inflammation
  - Collagen degradation
  - Impaired wound healing
  - Disrupted gut microbes
- The animals that eat the water fleas pick up glyphosate from their food
- Effects on water fleas propagate up the food chain

*Suppa et al. Microbiome (2020) 8:170.

Glyphosate-based formulations: Effect on honeybee behaviors*

Conclusions

"In this study, we provided new information on the influence of commercially formulated glyphosate at the recommended concentration on the behaviours of honeybees. Our findings showed that the water responsiveness, sucrose responsiveness, learning and memory ability and climbing ability of honeybees were affected by commercially formulated glyphosate at or below the recommended concentration."

*Qi-Hua Luo et al., Scientific Reports 2021; 11(1): 2115.

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

- Roundup exposure to vertically burrowing earthworms in a greenhouse experiment
- Surface casting activity almost ceased three weeks after herbicide application
- Herbicide application led to a 1592% increase in soil concentrations of nitrate and a 127% increase in phosphate
- Serious risk of nutrient leaching into streams, lakes or groundwater aquifers

“Reductions in mixing of organic litter within the soil will limit long-term soil microbial activity and soil nutrient cycling and availability, all of which may lead to reductions in plant productivity”

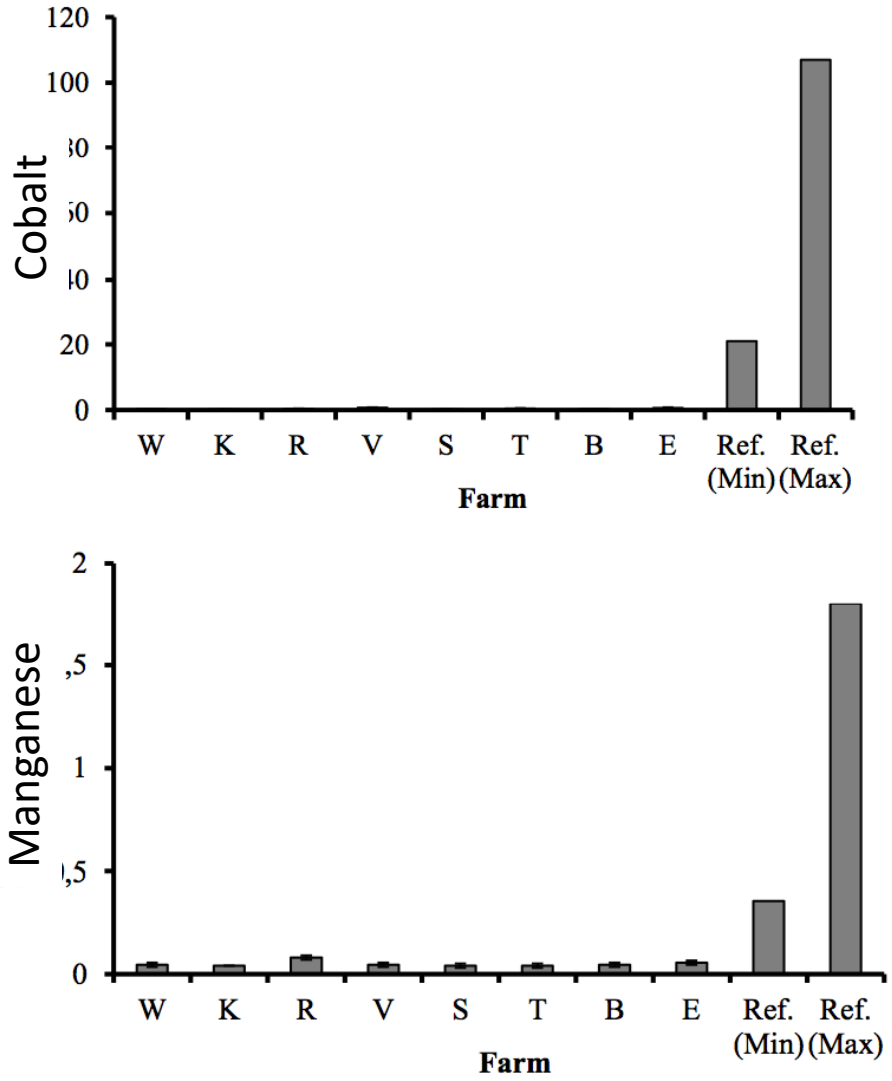
*Mailin Gaupp-Berghausen et al. Scientific Reports 2015; 5: 12886.

“Exposure to Glyphosate … Leads to Degeneration of γ-Aminobutyric Acid and Dopamine Neurons in *Caenorhabditis elegans*”*

- Parkinson's disease is caused by damage to dopaminergic neurons in the brain
- Agricultural workers have an increased risk to Parkinson’s disease associated with exposure to agrichemicals
- Chronic exposure to Touchdown (a glyphosate-containing herbicide) led to degeneration of dopaminergic and GABAergic neurons in brainstem nuclei in roundworms
- A manganese-containing fungicide also damaged these neurons

*R. Negga et al. Neurotox Res. 2012 April ; 21(3): 281–290.

Severe Deficiency in Manganese and Cobalt in Cows*



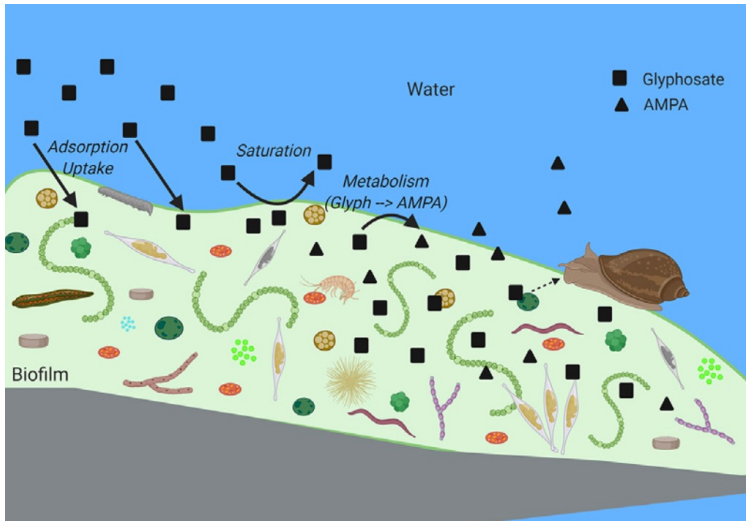
Eight different farms: all cows tested had glyphosate in the urine

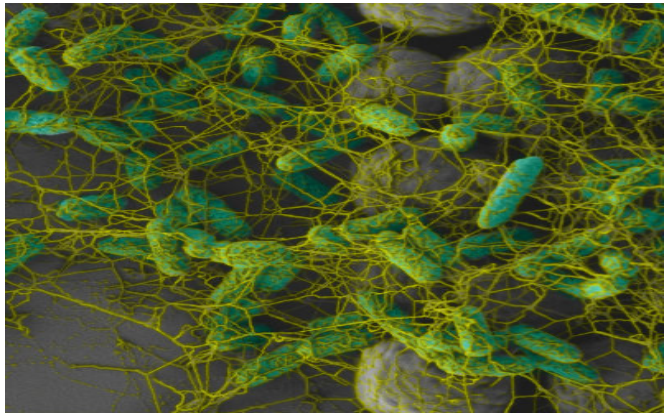
*M. Krüger et al., J Environ Anal Toxicol 2013, 3:5

An Example:
Florida Agriculture and Waterways

Glyphosate Accumulates in Biofilms*

- Glyphosate polluting waterways is rapidly adsorbed into biofilms
- Concentrations of glyphosate in biofilms were *two to four orders of magnitude higher* than those in the surrounding water
- Glyphosate appears to rapidly disappear from waterways, but this is an illusion
- Juvenile fish and amphibians dwell in the biofilms





"We may be underrecognizing the potential ecological risk of contaminants, like glyphosate, that are bioconcentrating in biofilms and subsequently being consumed."

*Laura Beecraft et al.Science of the Total Environment 756 (2021) 143993.

"Chronic exposure to glyphosate in Florida manatee”*

- Glyphosate is ubiquitous in Florida waterways
- Concentrations were higher during the sugar cane harvest
- Florida manatees exposed to glyphosate have increasing body burdens since 2009
- Manatees are sick and they are starving due to loss of seagrass

*Maite De Maria et al. Environment International 2021; 152: 106493.

“Is Agriculture’s Use of Glyphosate Feeding Lake O’s Explosive Algae Blooms?”

- Sugar cane agriculture is extensive all around Lake Okeechobee in S. Florida, and glyphosate is used both to control weeds and as a desiccant*
- Cyanobacteria can break down the C-P bond in glyphosate and use its phosphorus atom as a fuel source**

*Prof. Geoffrey Norris.https://jacquithurlowlippisch.com/tag/is-sugarcane-field-glyphosate-feeding-lake-os-blue-green-algae-blloms

**D Drzyzga et al. Environ Microbiol 2017; 19(3): 1065-1076

Cyanobacteria Feed Red Tide Algae

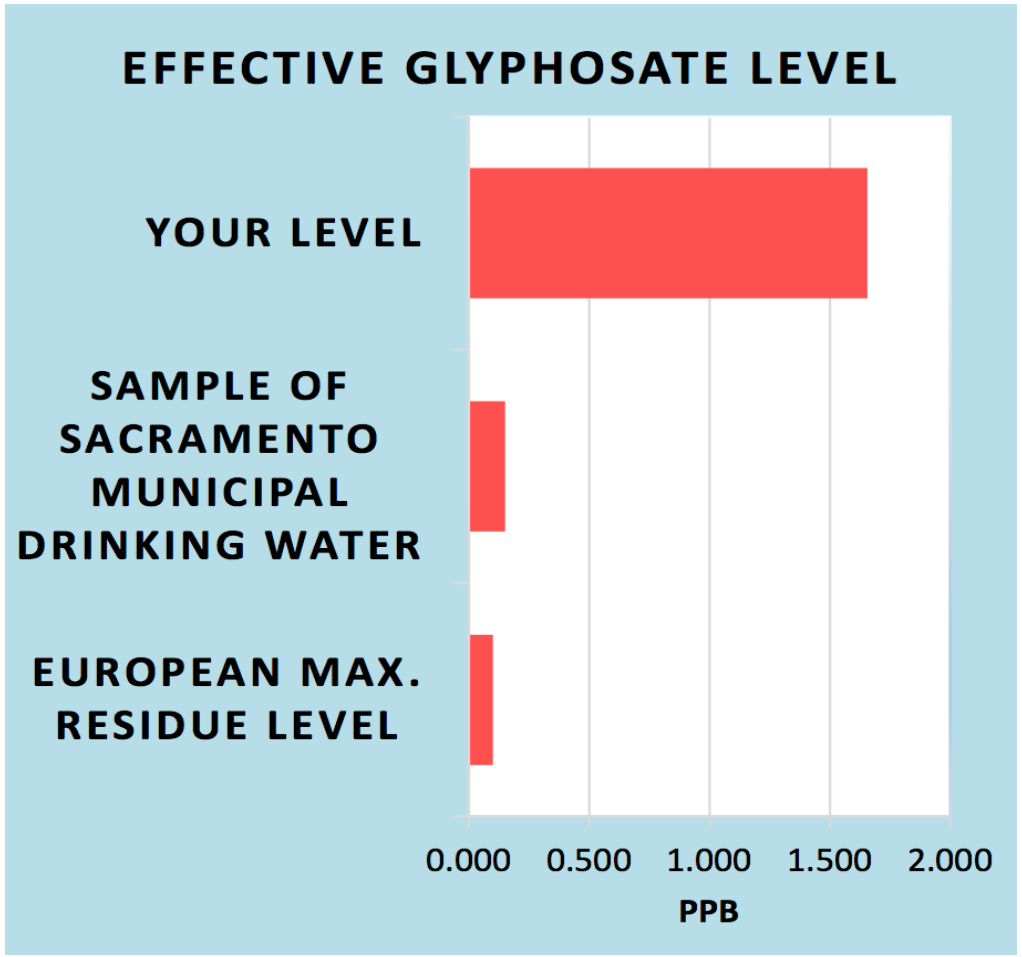
"Both the coastal red tide and the inland blue-green algae have beset South Florida through the summer, killing vast numbers of fish and other wildlife, including dozens of dolphins, manatees, sea turtles, sharks and eels."*

- Cyanobacteria feed off of glyphosate (phosphorus source) and produce nitrates from nitrogen
- Red Tide algae flourish, supplied with nitrates produced by cyanobacteria **

*https://www.nbcnews.com/news/us-news/toxic-red-tide-florida-researchers-investigate-what-s-making-it-n900771

**https://www.sailorsforthesea.org/programs/ocean-watch/nutrients-feed-red-tide

Test of Glyphosate Levels in Florida Waterways*



Moms Across America study

Water sample taken from the coast of Cape Coral, at the mouth of the Caloosahatchee River, where cyanobacteria were present

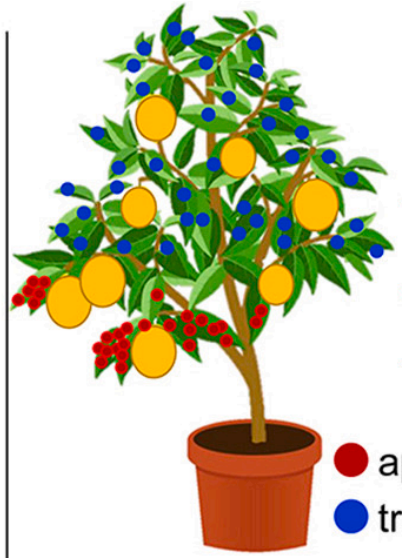
Florida orange juice samples tested positive for glyphosate

*https://www.momsacrossamerica.com/orange_juice_postive_for_glyphosate_again

“Glyphosate excessive use chronically disrupts the shikimate pathway and can affect photosynthesis and yield in citrus trees”*

Adult citrus plants with high glyphosate use, even with no phytotoxicity symptoms, show inhibited growth and fruit yield:

Hidden phytotoxicity?



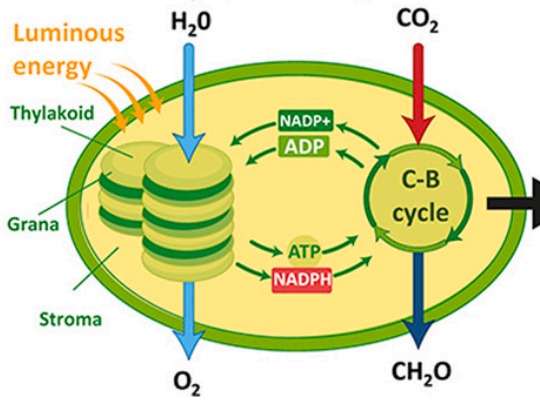
On sink leaves of 4-yr old plants:

GLY doses (mainly at >360 g ea ha^{-1}):

- ↑shikimate accumulation
- ↓net CO_2 assimilation
- ↓fruit yield

● applied GLY (source leaves)
● translocated GLY (sink leaves)

Luminous reaction and Calvin Benson cycle on chloroplasts



- ↑photooxidative damages
- ↓carboxylation
- ↑photorespiration: ↑C drain

*Rodrigo Martinelli et al. Chemosphere 2022; 308: 136468.

Concerns about Glyphosate and Citrus*

Chief among these concerns are:

- Increased crop sensitivity to diseases
- Reduced availability of micronutrients to crops through chelation by glyphosate
- Inhibition of root growth
- Citrus fruit drop

"As citrus weed management programs have continued to rely more heavily on glyphosate, the occurrence of citrus fruit drop resulting from glyphosate application has become an increasing grower concern over the years."

*http://citrusindustry.net/2018/09/05/how-to-handle-glyphosate-related-fruit-drop/

Summary

- Glyphosate is pervasive in our environment, and it is a significant contributor to human health issues and harm to the ecosystem
- Glyphosate usage on core crops has increased dramatically over the past two decades, in step with the dramatic increase in a number of human diseases and conditions
- Multiple species of animals, including water fleas, earthworms, bees, cows, manatees, etc., are being harmed
- Glyphosate disturbs the nutrients in the soil, chelating minerals and interfering with nitrogen uptake and photosynthesis
- Agriculture in Florida is leading to algae blooms, citrus greening, and harm to the Florida manatees