Signals That Show A Need To Use Glyphosate More Judiciously

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Importance of Reducing Stress

Genetic Potential - **Nutrition, Physiology, Management, Environment, Diseases, Pests** = **Harvest**

Genetic potential *minus* **Stress** *equals* **Yield**

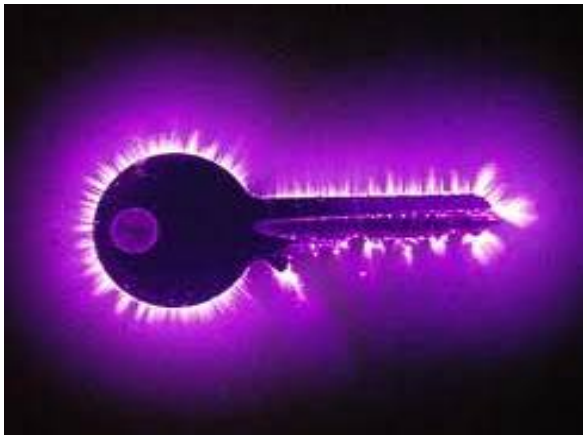




Nutrients are:

Components of plant parts as well as

Activators,



Inhibitors,

and Regulators

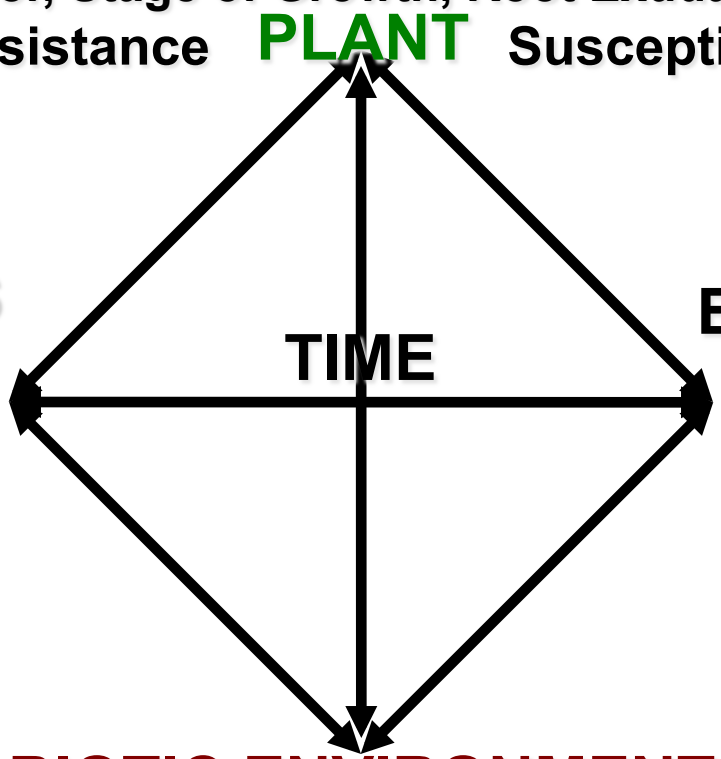
of Physiological Processes

Many herbicides and pesticides are chelators





Interacting Factors Determining Nutrient Availability and Disease Severity







UNDERSTANDING GLYPHOSATE

- **A strong chemical chelator**

Chelates minerals in the spray tank

Chelates minerals in the plant

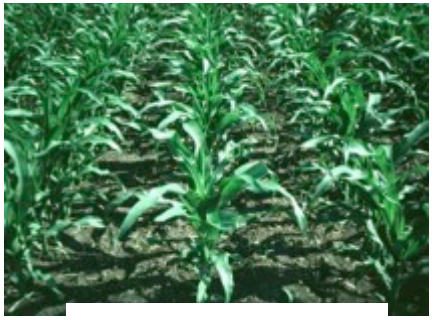
Chelates minerals in the soil

Reduces: B, Ca, Co, Cu, Fe, K, Mg, Mn, Ni, Zn

Chelating stability constants of glyphosate

Metal ion	[ML] [M][L]	[MHL] [M][H][L]	[ML2] [M][L2]
Mg2+	3.31	12.12	5.47
Ca2+	3.25	11.48	5.87
Mn2+	5.47	12.30	7.80
Fe2+	6.87	12.79	11.18
Cu2+	11.93	15.85	16.02
Fe3+	16.09	17.63	23.00

- **Non-specific herbicidal effect**



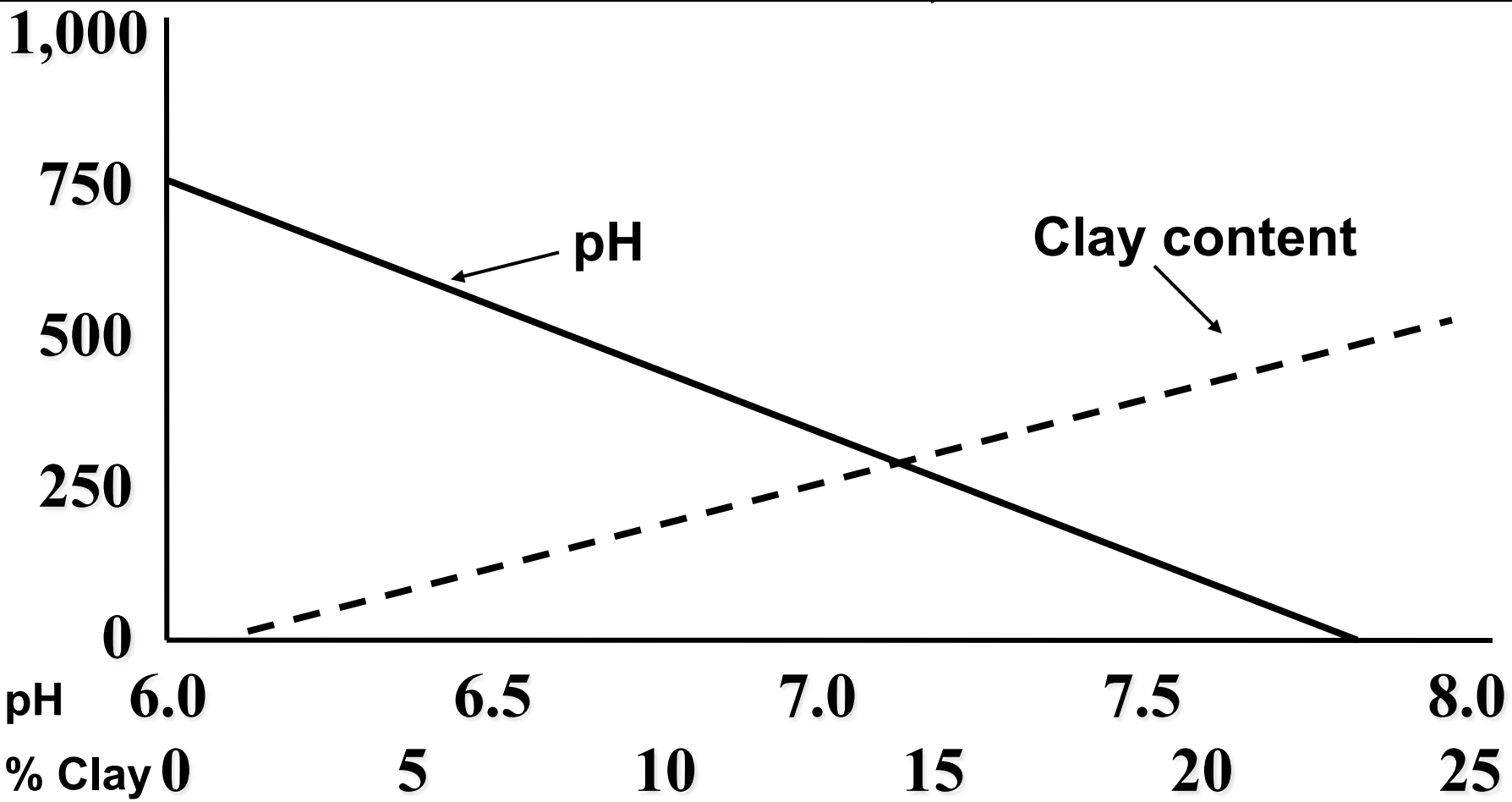
Glyphosate

Glyphosate + Zn tank mix

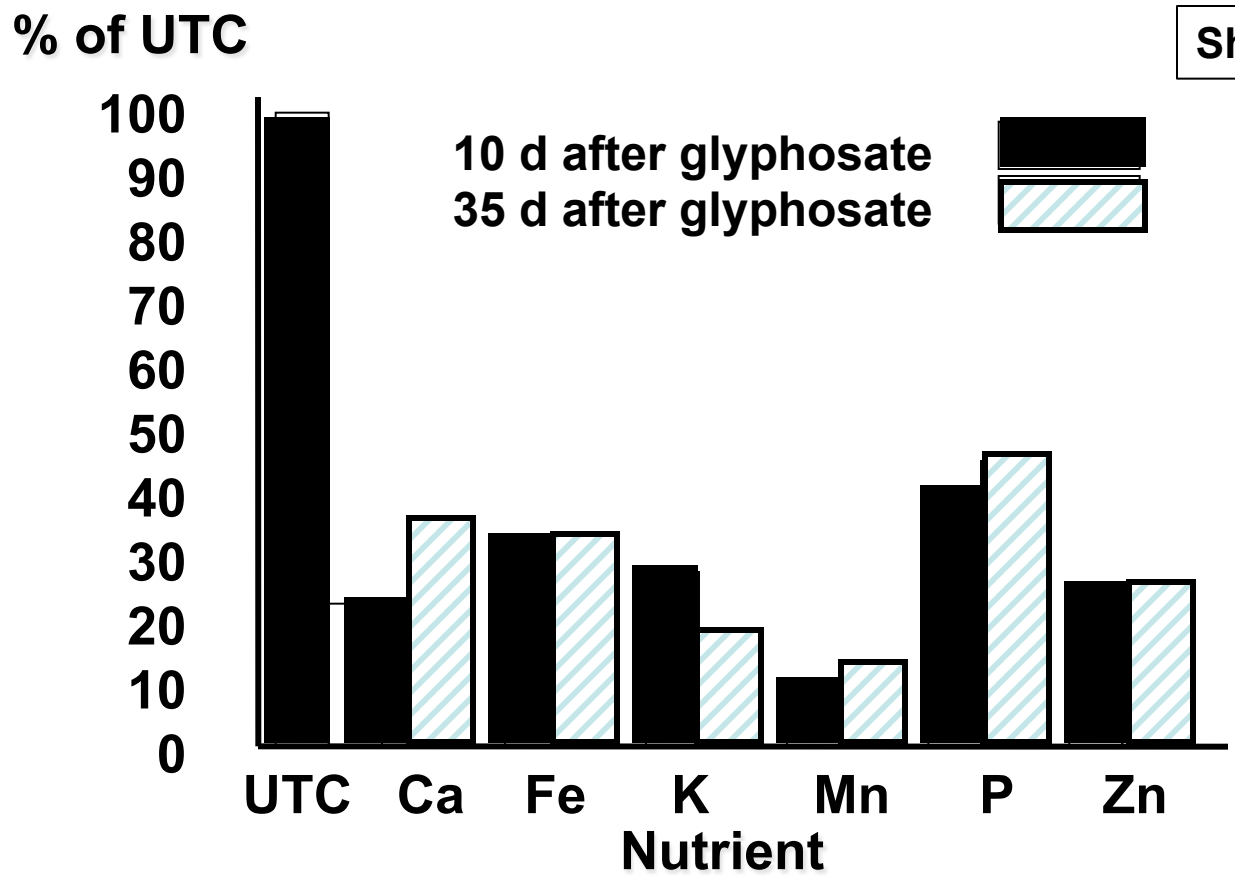
Gyphosate Immobilizes nutrients

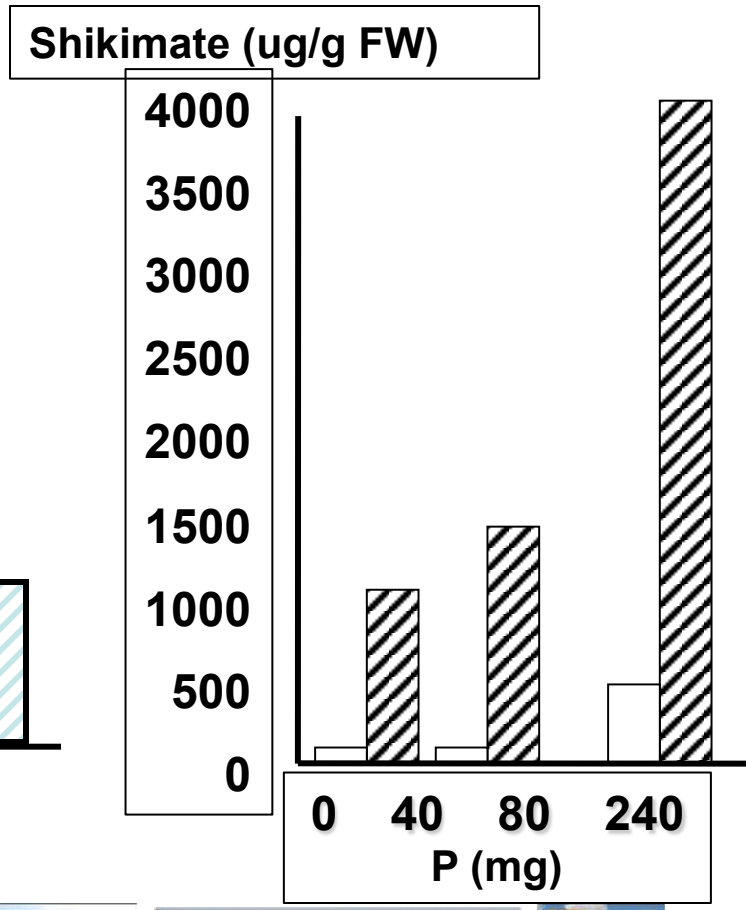
Factors Affecting Soil Sorption of Glyphosate

After Farehnorst et al, 2009



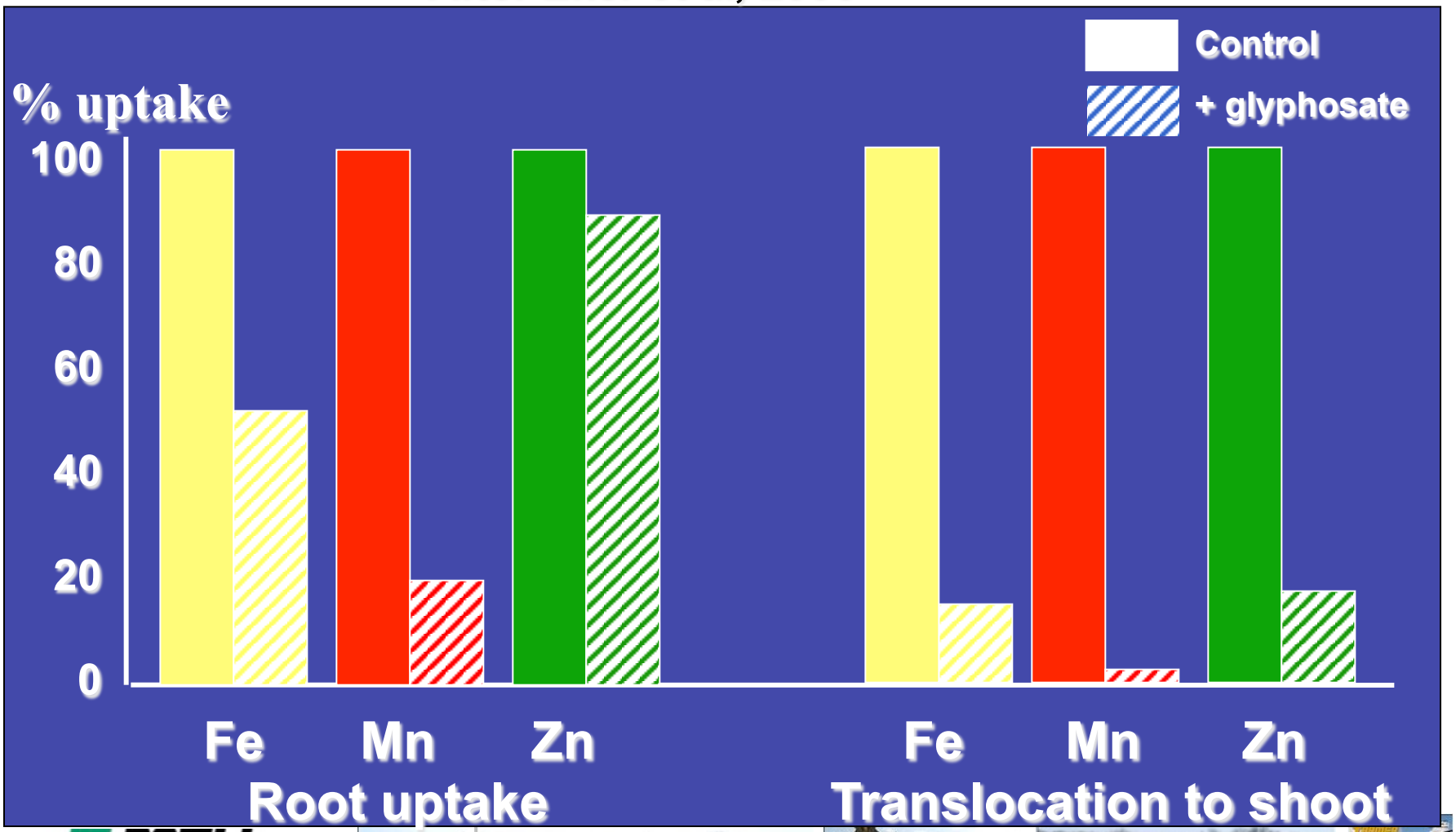
Effect of P Desorption of Glyphosate

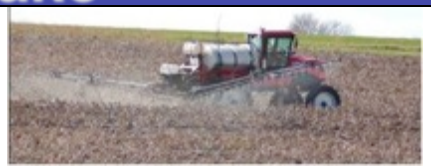


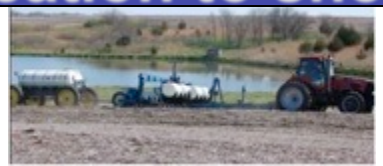


Effect of 'Drift' Glyphosate on Nutrient Uptake

After Eker et al, 2006






1. Glyphosate is a systemic, broad-spectrum herbicide that intensifies stress

2. Glyphosate accumulates in plant tissues (shoot and root tips, reproductive structures, and legume nodules)

3. Some glyphosate moves into roots and is released into soil

4. Makes the plant susceptible to diseases

5. Increases virulence of soil-born disease organisms

6. Is toxic to normal biological control and other beneficial organisms

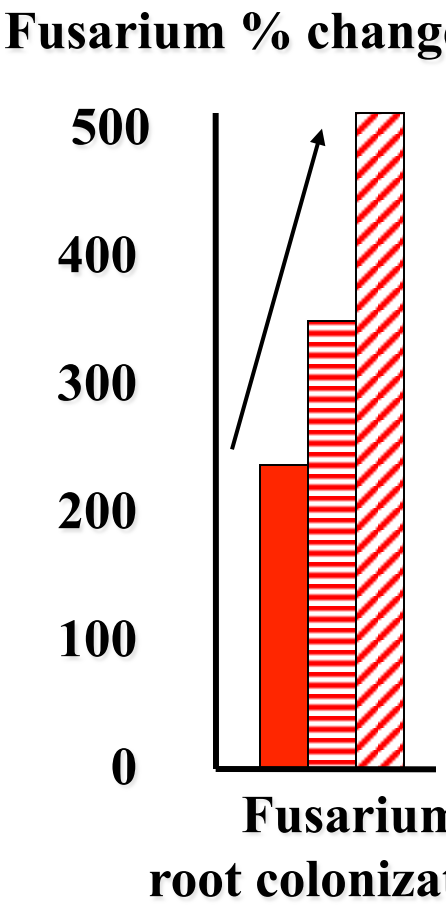
7. Glyphosate accumulates in soil
(fast sorption; slow degradation)
Desorbed by phosphorus

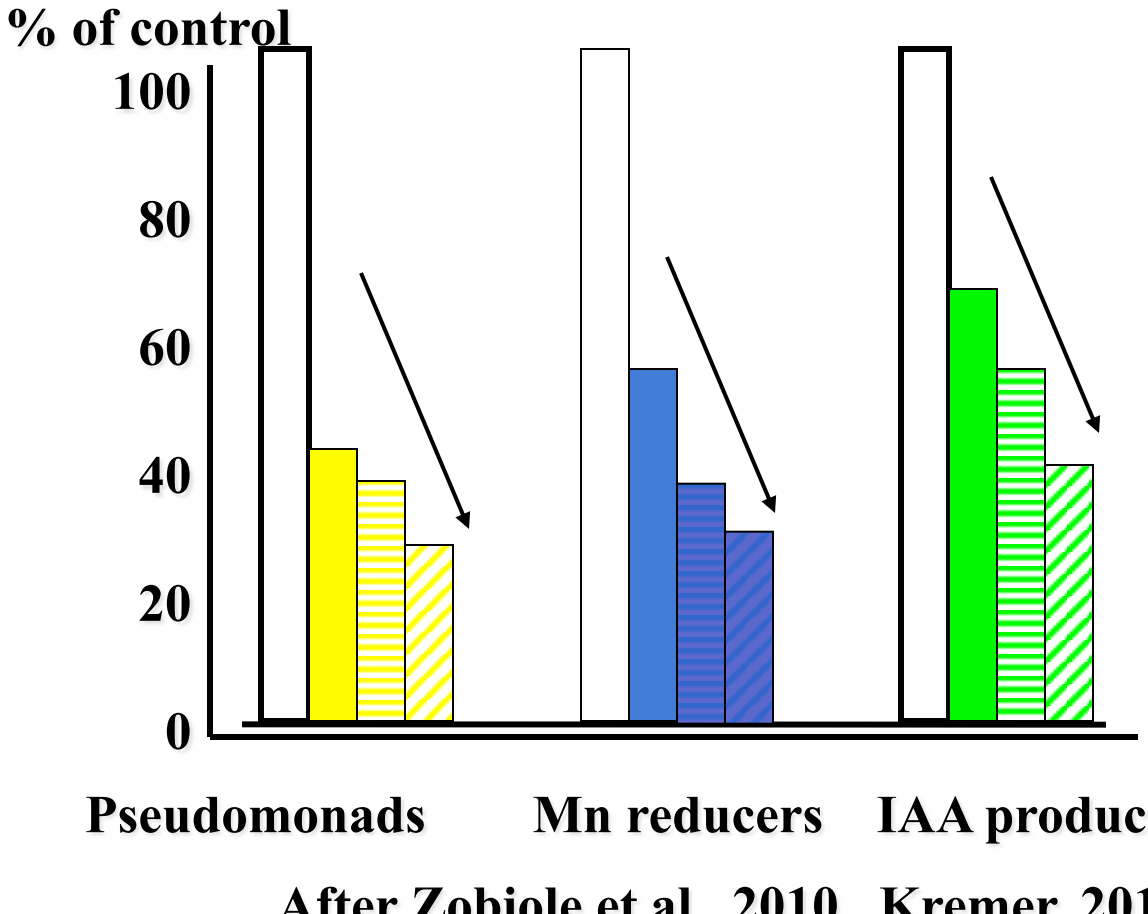
Beneficial soil organisms include
- N-fixing microbes
  - Any with bacterial shikimate pathway
- N-fixing organisms
  - Mycorrhizae
  - Biological control organisms
  - Earthworms
  - Plant Growth Promoting organisms





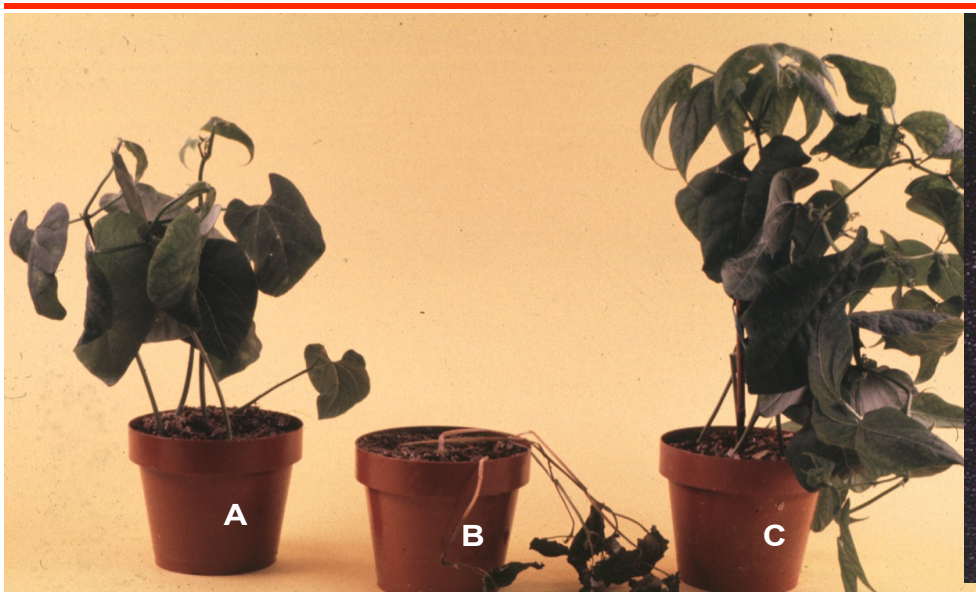
Microbiocidal Activity of Glyphosate

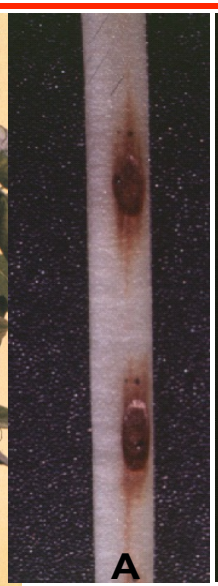




After Zobiole et al., 2010, Kremer, 2010

Herbicide action is by soil-borne fungal pathogens
Glyphosate Increases Disease Susceptibility





Glyphosate Sterile soil

Glyphosate Field soil

No glyphosate Control

Effect of glyphosate on susceptibility to anthracnose. A) hypersensitive response B) non-limited response after glyphosate is applied.

After Rahe and Johal, 1988;1990; Johal and Huber, 1999; Schafer et al, 2009,2010.

Role of Soil Pathogens in Response to Glyphosate

- Glyphosate increased susceptibility to *Pythium and Fusarium* - readily colonized susceptible giant ragweed roots when treated with glyphosate
- Resistant Giant Ragweed in unsterile soil were killed by a 4x rate of glyphosate, yet susceptible biotypes were not killed with the same rate in sterile soil.
- Resistant giant ragweed biotypes were resistant to *Pythium and Fusarium*

Glyphosate susceptible biotype 4 DAT

Pythium Control | Pythium + glyphoste | Glyphosate control

Glyphosate treated

Susceptible biotype | Resistant biotype

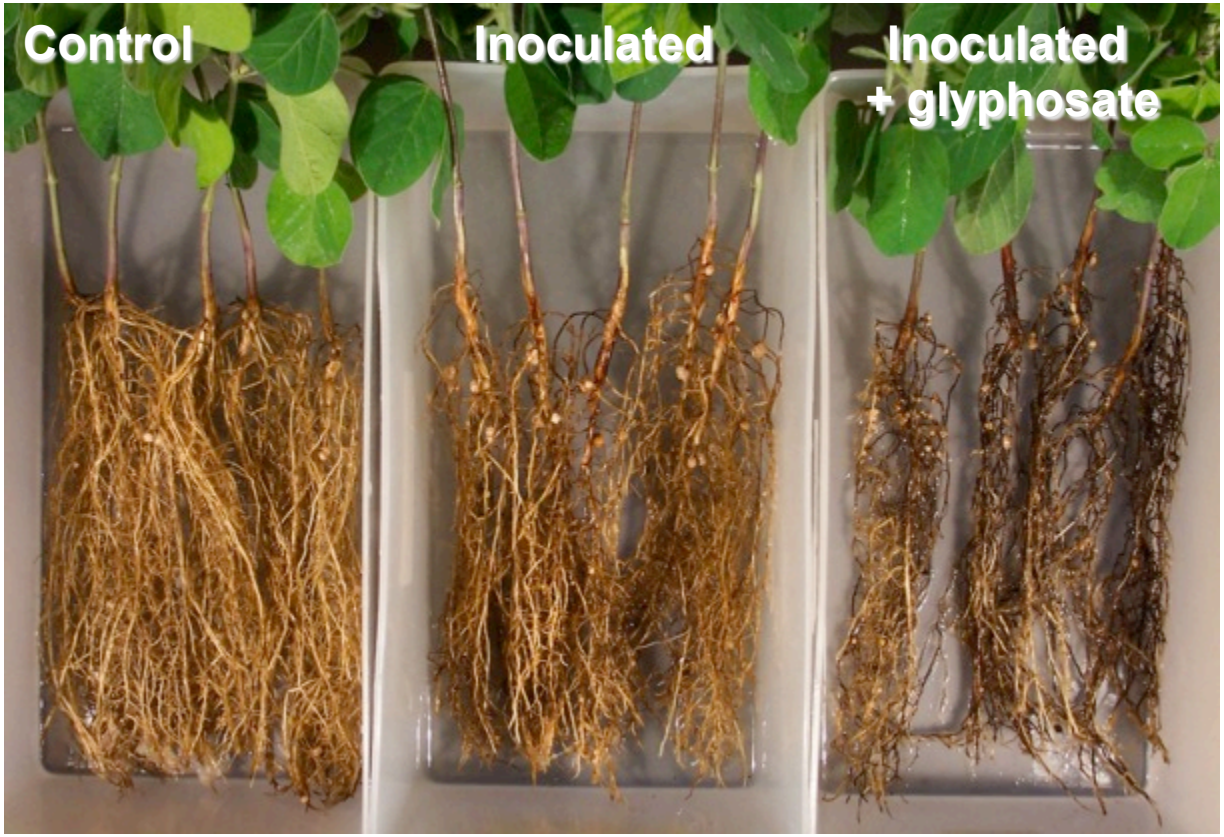
Ridomil | Ck | Ridomil | Ck

Fungicide





Effect of Glyphosate on Corynespora RootRot







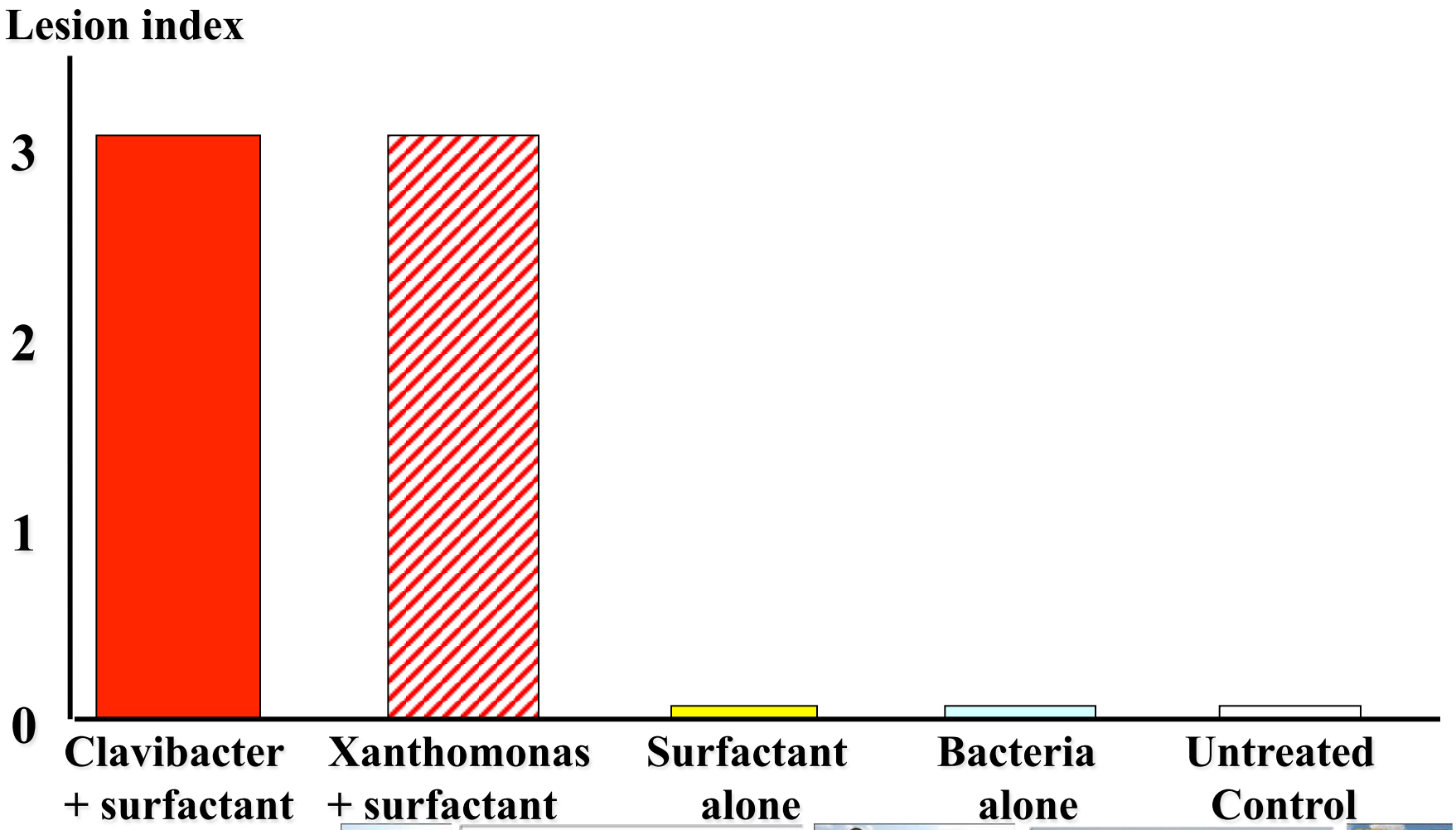
Glyphosate Predisposition To Sudden Death Syndrome

Glyphosate Predisposition to Goss' Wilt





Predisposition to Goss' and Stewart's Wilt



Predisposition to Severe Take-all

Take-all of wheat after glyphosate to RR beans





Glyphosate Predisposition to Fusarim Head Blight

- ✓ *Environment* was the most important factor in FHB development in eastern Saskatchewan, from 1999 to 2002
- ✓ *Application of glyphosate formulations* was the most important agronomic factor associated with higher FHB levels in spring wheat

(Fernandez et al. 2005, *Crop Sci. 45: 1908-1916*)
(Fernandez et al., 2007, Crop Sci. 47:1574-1584)

Number of glyphosate applications the previous three years	% Increase in head scab
None	100
1 to 2	152 ***
3 to 6	295 ***





What's Special About Genetic Engineering for Glyphosate Tolerance? (Roundup Ready®)

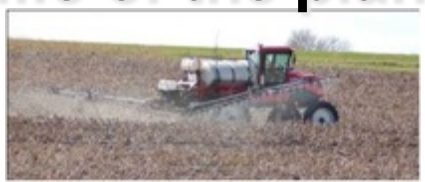
- **The technology inserts an alternative EPSPS enzyme that is not blocked by glyphosate in *mature* tissue**

- **There is nothing in the RR plant that operates on the glyphosate applied to the plant!**

  Glyphosate chelation is not selective it immobilizes nutrients

- **Can cause a "Yield Drag"**

- **It is there for the life of the plant**


Reduced Nutrient Efficiency of Isogenic RR Soybeans (After Zobiole et al, 2008, 2009)

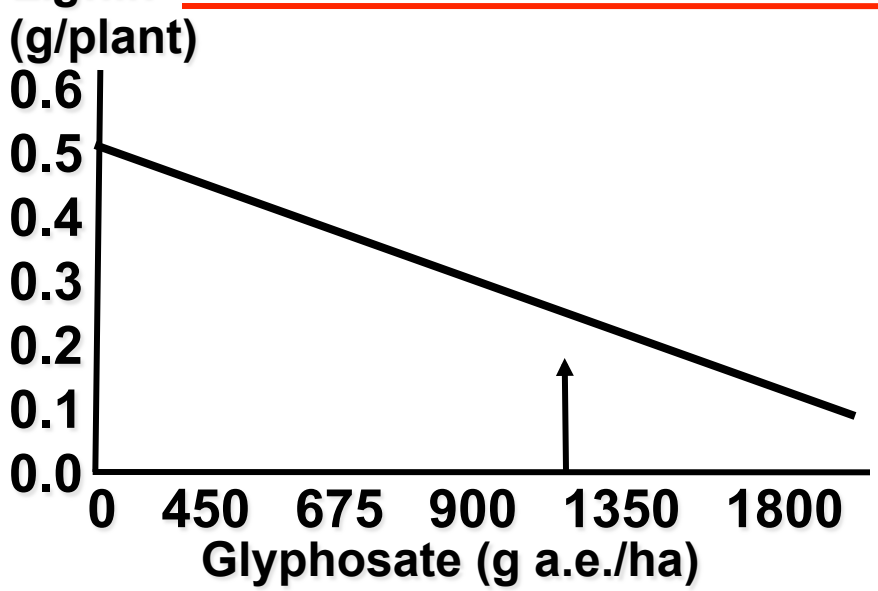
Tissue:	Mn	Zn	Variety range
Isoline	%	%	%
Normal	100	100	100
Roundup Ready©	83	53	10-70
RR + glyphosate	76	45	

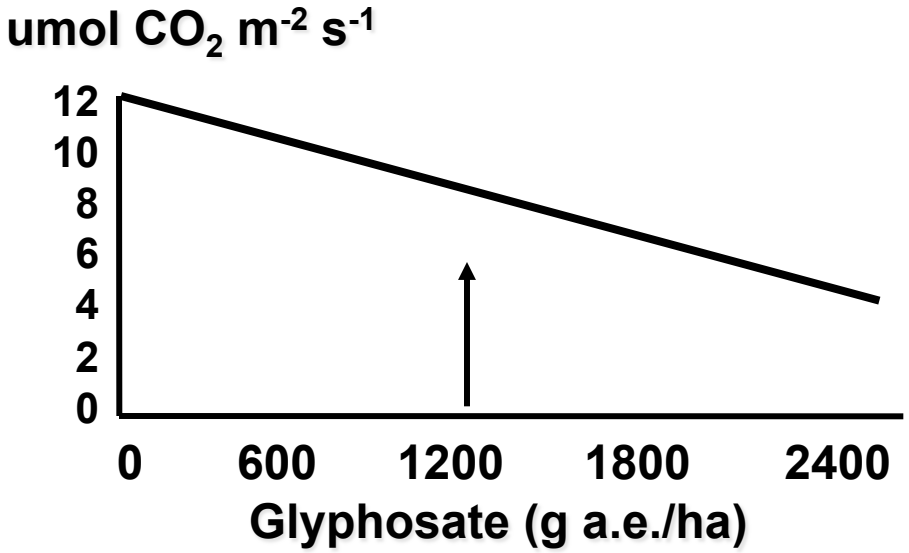


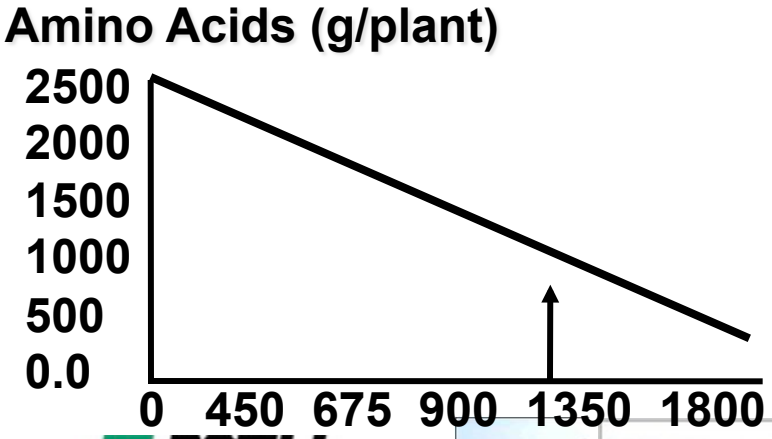


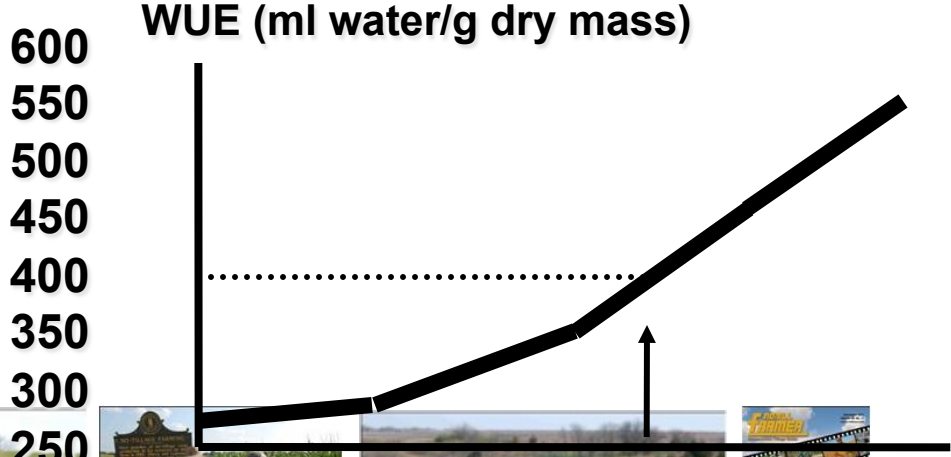
Effect of Glyphosate on 'Glyphosate-Resistant' Soybeans

After Zobiole, 2009









% Mineral Reduction in Roundup Ready® Soybeans Treated with Glyphosate

After Cakmak et al, 2009

Plant tissue	Ca	Mg	Fe	Mn	Zn	Cu
Young leaves	40	28	7	29	NS	NS
Mature leaves	30	34	18	48	30	27
Mature grain	26	13	49	45		

Reduced:

Yield = 26%; Biomass = 24%





Long-term Effect of Glyphosate

Special Considerations in Fertilizing RR Crops

Two factors: 1) Chemical; 2) gene

1. Providing nutrient availability for yield and quality

Compensate for reduced plant efficiency
Compensate for reduced soil availability

2. Detoxifying residual glyphosate

In meristematic root, stem, flower tissues, etc.
In soil [Ca, Co, Cu, Mg, Mn, Ni, Zn]

3. Restoring soil microbial activity

Nutrient related (N-fixation, Fe, Mn, Ni, S, Zn, etc.)
Disease control related (nutrition, pathogen antagonists, etc.)
Biological amendment (N-fixers, PGPRs, etc.)

4. Judicious use of glyphosate

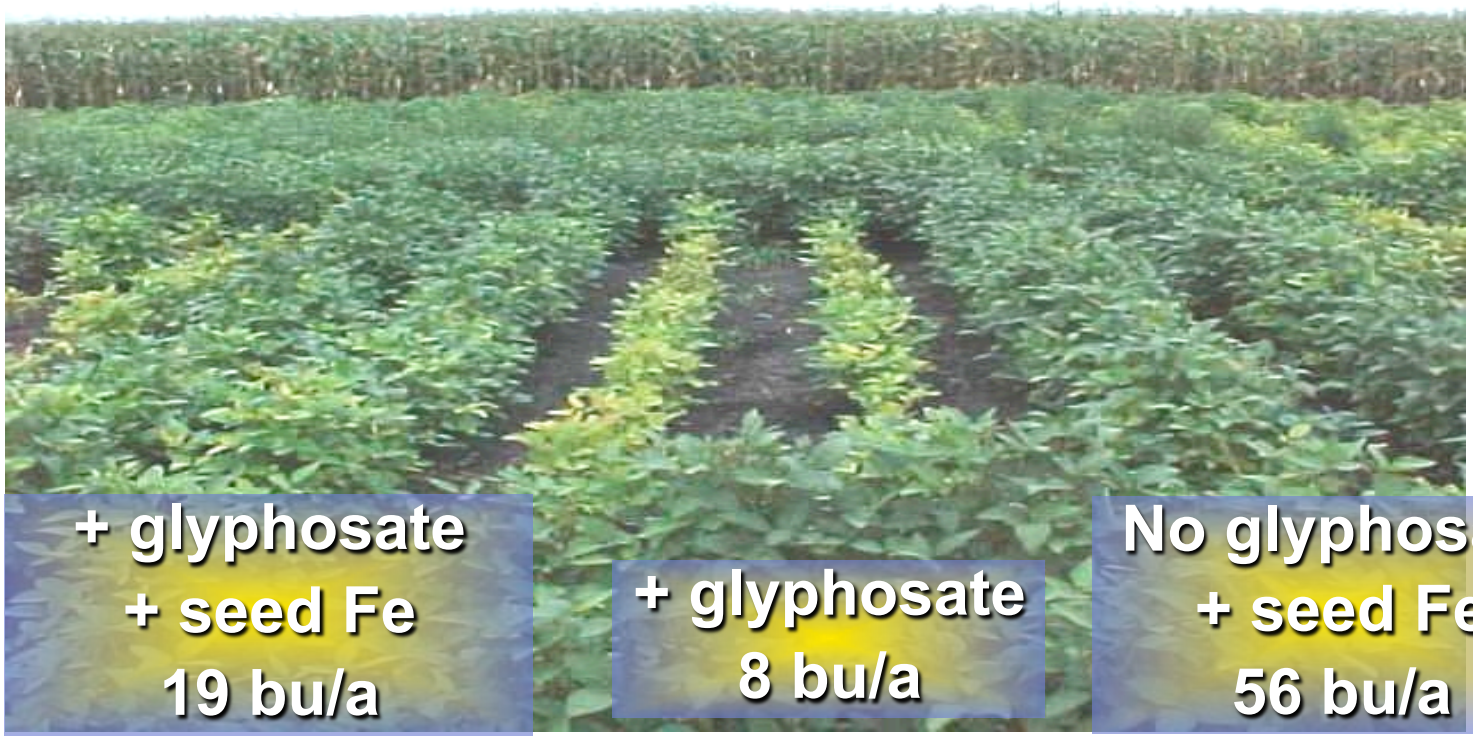
Yield Response of Roundup Ready® Soybeans to Micronutrients

Treatment	Indiana	Michigan	Kansas	Minnesota
	Yield (bu/a)			
Untreated	46	24	77	33
Glyphosate only	57	33	65	8
Glyphosate + Micronutrient	75 Mn	56 Mn	78 Mn	19 Fe





Glyphosate-induced Fe-deficiency







Response of Roundup Ready© Corn to Zn & Mn

Colorado State University, 2007
Mike Bartolo, Sr. Res. Scientist

Treatment	Yield (bu/a)	% of control
Untreated*	234 a	100
Glyphosate**	195 d	83
Glyphosate + Zn, Mn	221 b	94

*Hand weeded, **1 lb a.i. + 1 pt AMS/acre
**Glyphosate reduced genetic potential 39 bu/a

2007, North Dakota State University, Carrington

Treatment*	Yield (bu/a)	Increase (bu/a)
Glyphosate control	144	---
Foliar applied Zn	158	14
Soil granular Zn sulfate	167	23
Foliar applied Zn+Mn	173	29
Seed + Foliar Zn	175	31

* All treatments received glyphosate





Herbicide Affects on RR Corn Yield,Indiana, 2010

	RR Corn Hybrid			
Herbicide	6733HX	6179VT3	5442VT3	5716A3
Surestart (11”)	266*	216	223	219
Cadet (V6)	227	219	219	213
Laudis (V6)	224	218	214	214
Integrity (pre-E)	231	217	215	204
Glyphosate (V6)	*212*	*207*	*206*	*210*
Steadfast (V6)	207	204	201	196
Status (V6)	187	195	193	192

*125.6 % of glyphosate yield (yields in bu/a - rounded); All plots were hand weeded






Untreated Check (conventional herbicide)


Glyphosate @ 22 oz/ac plus AMS)

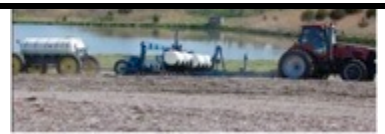

Glyphosate @ 22 oz/ac plus AMS + Manganese

Effect of glyphosate and Manganese on Cotton Yield (Texas)

Treatment	% chlorotic plants	# seed cotton
Conventional herbicide	5	4885
Glyphosate	97	2237
Glyphosate + Mn, Zn	2	4693

after Ronnie Phillips, 2009




Food and Feed Safety Concerns

- **Nutrient deficiency**
  - Co, Cu, Fe, Mg, Mn, Zn
- **Increased levels of mycotoxins**
  - Fusarium toxins (DON, NIV, ZEA)
  - Aflatoxins
- **Gene flow**
  - Weeds
  - Soil microbes
  - Intestinal microbes
- **Direct toxicity of residual glyphosate**
  - Infertility - endocrine system
  - Birth defects, teratogenicity
  - Cell death
  - Intestinal microflora and Disease resistance
- **Allergenic reactions to foreign proteins**

Aris & Leblanc, 2011
Benachour et al, 2007
Carmen, et al., 2011
Fernandez, et al., 2009
Gasnier, et al., 2009
Heiman, 2010
Matzk et al, 1996
Seralini et al., 2010, 2011
Smith, 2010
Walsh, et al., 2000
Watts, 2009





% Reduction in Alfalfa Nutrients by Glyphosate*

Nutrient	% reduction compared with Non-RR
Nitrogen	13 %
Phosphorus	15 %
Potassium	46 %
Calcium	17 %
Magnesium	26 %
Sulfur	52 %
Boron	18 %
Copper	20 %
Iron	49 %
Manganese	31 %
Zinc	18 %

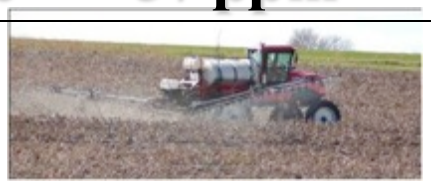
Manganese Sufficiency in Bovine Fetus Livers

(After Schefers, 2011)

Fetal development	Mn mean	Manganese level*		
		Deficient	Normal	Above
Deformed	0.88 ppm	100 %	0	0
'Normal'	1.2 ppm	63 %	29 %	7 %

*Reference range: 1.75-2.8 ppm wet weight

Feed Analysis:	Mean Mn	Range of samples
Shelled corn	15 ppm	0.01 - 57.65 ppm
Corn silage	37 ppm	0.01 - 89.43 ppm
Grass hay	50 ppm	0.01 - 125.20 ppm
Mixed haylage	57 ppm	0.55 - 113.45 ppm

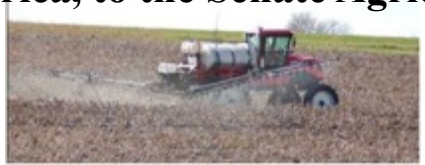

U.S. Cattlemen's Association Statement to Congress

"Cattle ranchers are facing some puzzling - and, at times, economically devastating problems with pregnant cows and calves. At some facilities, high numbers of fetuses are aborting for no apparent reason. Other farmers successfully raise what look to be normal young cattle, only to learn when the animals are butchered that their carcasses appear old and, therefore, less valuable."

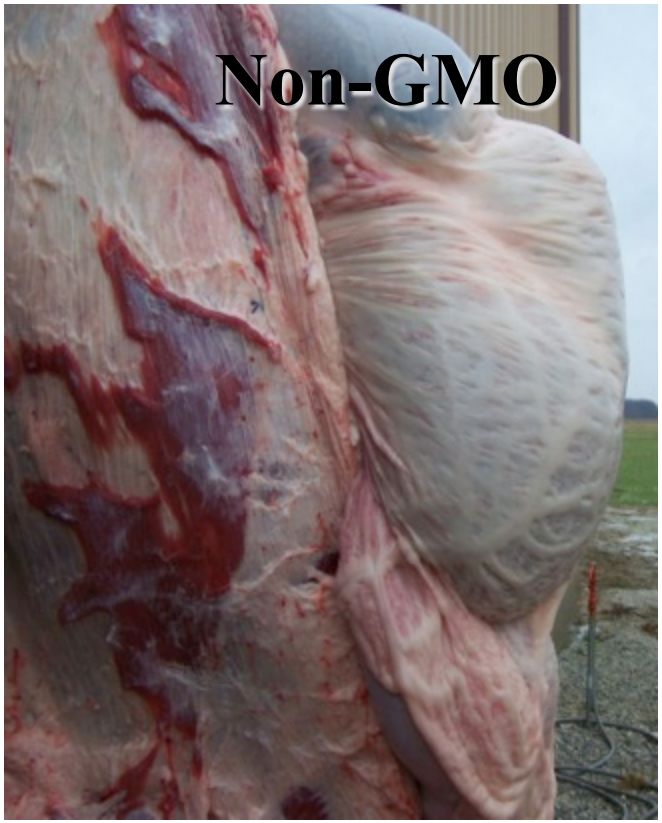
"The sporadic problem is so bad both in the United States and abroad that in some herds around 40-50 percent of pregnancies are being lost."

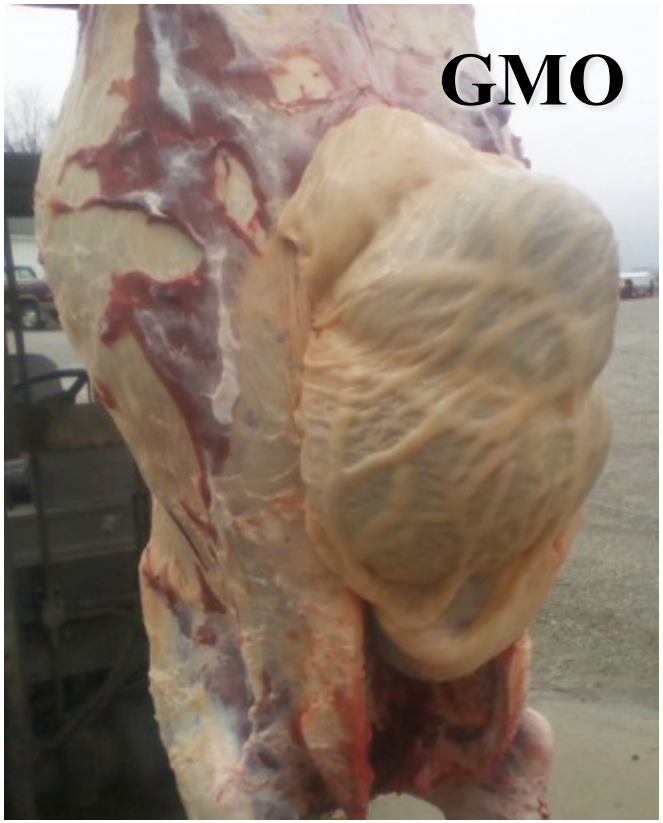
"The viability of this important industry is threatened."

Source: Testimony of the Ranchers-Cattlemen Action Legal Fund, United Stockgrowers of America, to the Senate Agriculture Committee July 24, 2002.


Feed Source Effect on Stomach Liner Color, IA, 2010





Effect of the GM "Gene" Proteins in Corn/Soybeans on Pig Stomachs

IA, 2010

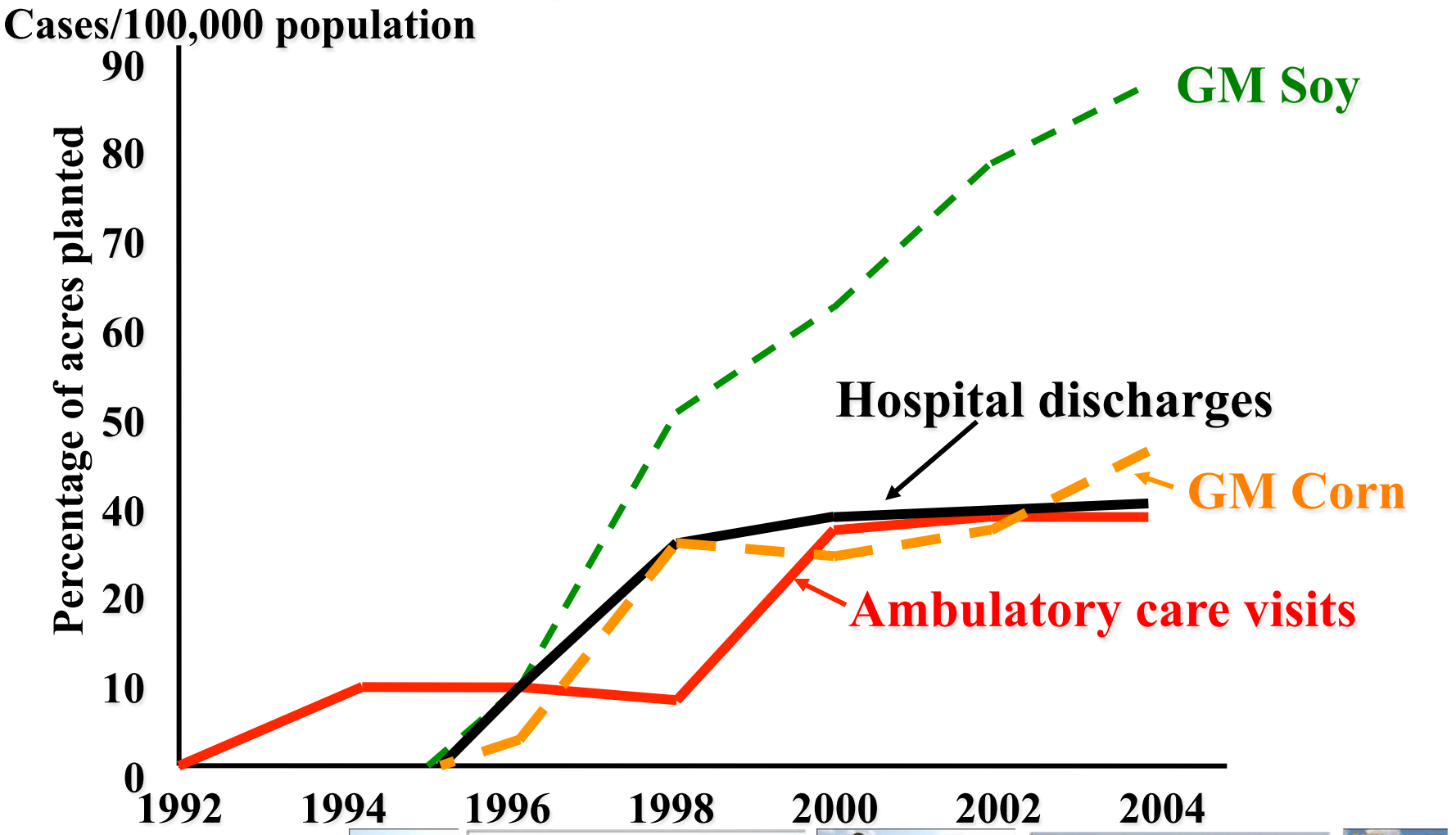
Non-GMO Feed

GMO Feed





Inflammatory Bowel Disease, USA







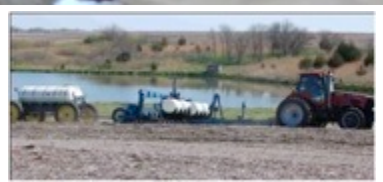
And the Mice Prefer……

GMO Corn

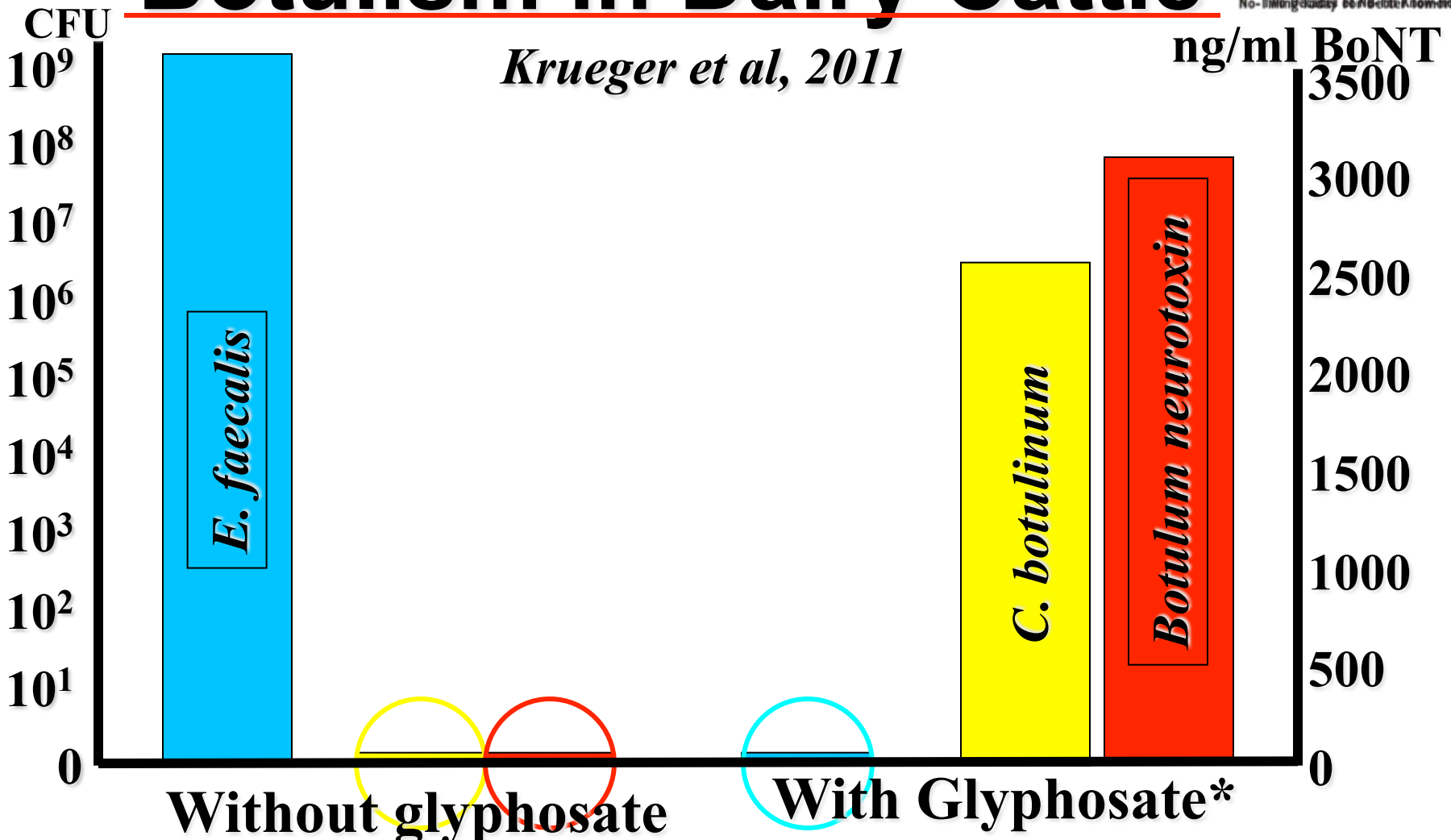
Non-GMO Corn

Photos: Gilbert Hostetler



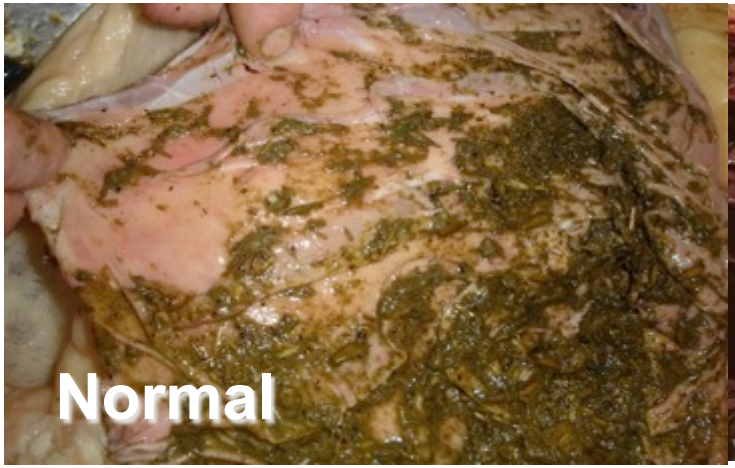




Botulism in Dairy Cattle



*0.01 mg glyphosate ml^{-1}

Cattle Stomachs



Photos: Dr. M. Krueger

Direct Toxicity of Glyphosate

Rate (ppm)	System affected	Reference
0.5	Human cell endocrine disruption	Toxicology 262:184-196, 2009
0.5	Anti-androgenic	Gasner et al, 2009
1.0	Disrupts aramatase enzymes	Gasnier et al, 2009
1-10	Inhibits LDH, AST, ALF enzymes	Malatesta et al, 2005
1-10	Damages liver, mitochondria, nuclei	Malatesta et al, 2005
2.0	Anti-Oestrogenic	Gasnier et al, 2009
5.0	DNA damage	Toxicology 262:184-196, 2009
5.0	Human placental, umbilical, embryo	Chem.Res.Toxicol. J. 22:2009
10	Cytotoxic	Toxicology 262:184-196, 2009
10	Multiple cell damage	Seralini et al, 2009
10	Total cell death	Chem.Res.Toxicol. J. 22:2009
All	Systemic throughout body	Andon et al, 2009
1-10	Suppress mitochondrial respiration	Peixoto et al, 2005
	Parkinson's	El Demerdash et al, 2001
POEA, AMPA even more toxic		Seralini et al, 2009





Late term 'Spontaneous Abortion' (Miscarriage)





Why are so many cows losing pregnancies?

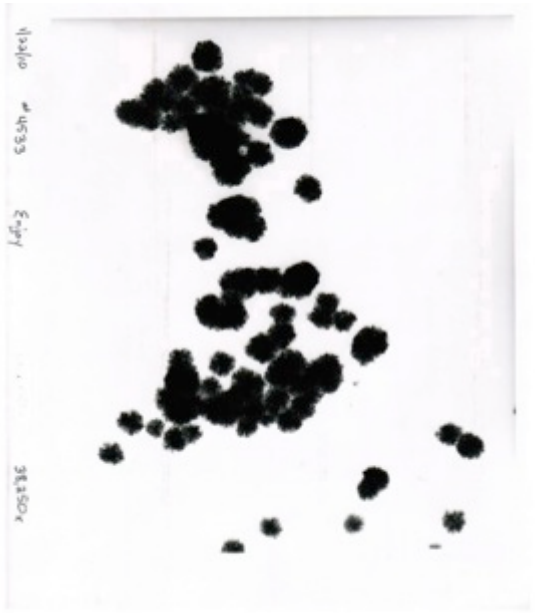
Losing up to 20 percent of pregnancies is not acceptable.

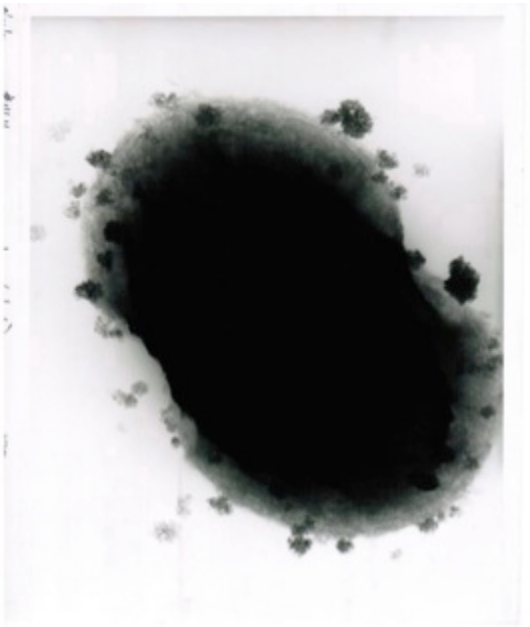
By Jenks Britt, D. V. M. and Fernando Alvarez, M. V. Z.

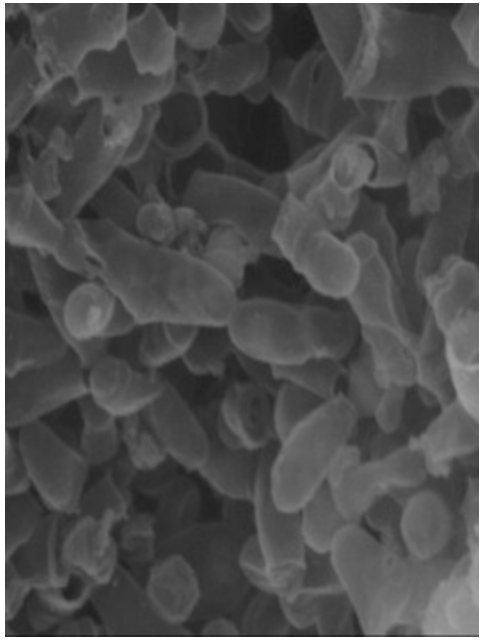
Characteristics	Herd A	B	C	D	E	F
Total cows	1,805	1,211	721	2,007	226	1,083
% herd pregnant	47	49	48	61	47	50
1st service conception	28	27	30	32	41	41
Services for all cows	4.3	4.1	3.6	3.0	2.5	2.4
% pregnant now open	27	25	27	10	6	2

Source: Hoards Dairyman, November 2011, p751.

Pure Culture' of Entity Causing Reproductive Failure in Animals







38,250 X magnification

Size relative to gram+ bacterium

SEM of entity

Occurrence

- Verified in IA, IL, KY, MI, NE, ND, SD, WI
- Sources: 'Environmental'

Environmental	Animal tissue
Soybean meal	Placental tissue
Silage	Amniotic fluid
Corn grain and silage	Semen
SDS Soybean plants	Stomach contents
Manure	Eggs
Soil	Milk

Fusarium solani fsp *glycines* mycelium





Potential Interactions of 'new entity' with Glyphosate

- **Glyphosate affects plants (predisposes):**
  - Inhibits plant defenses, Increases root colonization
  - Reduces nutrient content and efficiency [chemical and RR gene(s)]
  - Increases membrane permeability
- **Glyphosate affects animals (predisposes):**
  - Inhibits aramatose system – endocrine hormone system
  - Toxic to liver, placental, testicular, and kidney cells
  - Reduced defense - liver function; GI Tract Biocontrols
- **Glyphosate affects pathogens:**
  - Stimulates growth and virulence (direct/indirect)
  - Favors synergism, infection (as a carrier)
  - Increases movement into plant tissues (water film for plant infection)
- **Glyphosate affects the environment:**
  - Toxic to soil microbes that constrain plant pathogens
  - Micronutrient availability reduced





Failure to Honor

* **Scientific Precautionary Principle**
  1. **Margin of safety to prevent damage**
  2. **Anticipation of unknowns**
  3. **Initiate as a "pilot project"**

* **Not "Substantially Equivalent"-Significant deviation in:**
  1. **Expression of 'end products' (new/tissues in)**
  2. **More like virus infection than sexual transfer**
  3. **Functional and regulatory controls absent**
  4. **Greatly extended exposure**
  5. **Production, quality, safety & toxicity differ**

After Brown, 2000





Potential Far-Reaching Impact of Glyphosate

Human
Mineral malnourished,
Allergies, Fertility, Disease
MYCOTOXINS
Alzheimer's, gout, diabetes, viruses, Parkinson;s, etc.

Vegetables, fruits, grains
Lower nutrient minerals
(Cu, Fe, Mg, Mn, Zn)
Carriers for epiphytes
(E. coli, etc.)
(Changed epiphytic flora)

Glyphosate
Mn, etc.
Glyphosate
Chelation)

Plants, feed
Lower nutrient minerals
(Cu, Fe, Mn, Zn)
Disease predisposition
(Scab, take-all, CVC)
Mycotoxins, glyphosate

Environment
Biological imbalance
N fixation, Mn availability
Potassium immobilization
Biological controls
GLYPHOSATE ACCUMULATION

Animals
Mineral malnourished
Slow growth, Allergies, Disease
MYCOTOXINS
Scours, death, BSE, wasting,
predisposition to botulism





Future historians may well look back and write about our time, not about how many pounds of pesticide we did or did not apply; but by how willing we were to *sacrifice our children and jeopardize future generations with this massive experiment that is based on false promises and flawed science*, just to benefit the 'bottom line' of a commercial enterprise.