

Micronutrient - boron

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Thank you!



a&lgreatlakes
LABORATORIES
Scientists who don't mind getting dirty.™



**Purdue Crop
Diagnostic
Training and
Research Center**

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Hatch Project 1010713**

Roles of boron in plant nutrition

- Stabilizes cell walls and membranes
- Involved in sugar transport
- Required for normal development of meristematic tissue: xylem, root tips, pollen tubes
- Deficiency symptoms: death of meristems, failure to pollinate
- Not readily translocated in the plant

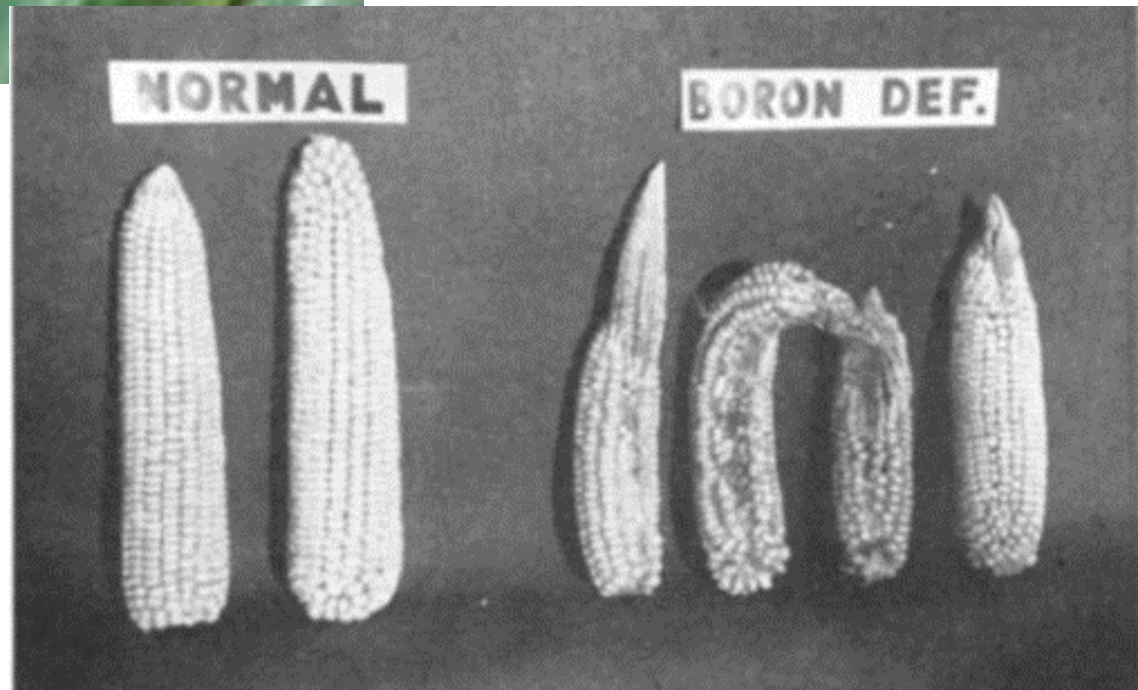
Soil boron

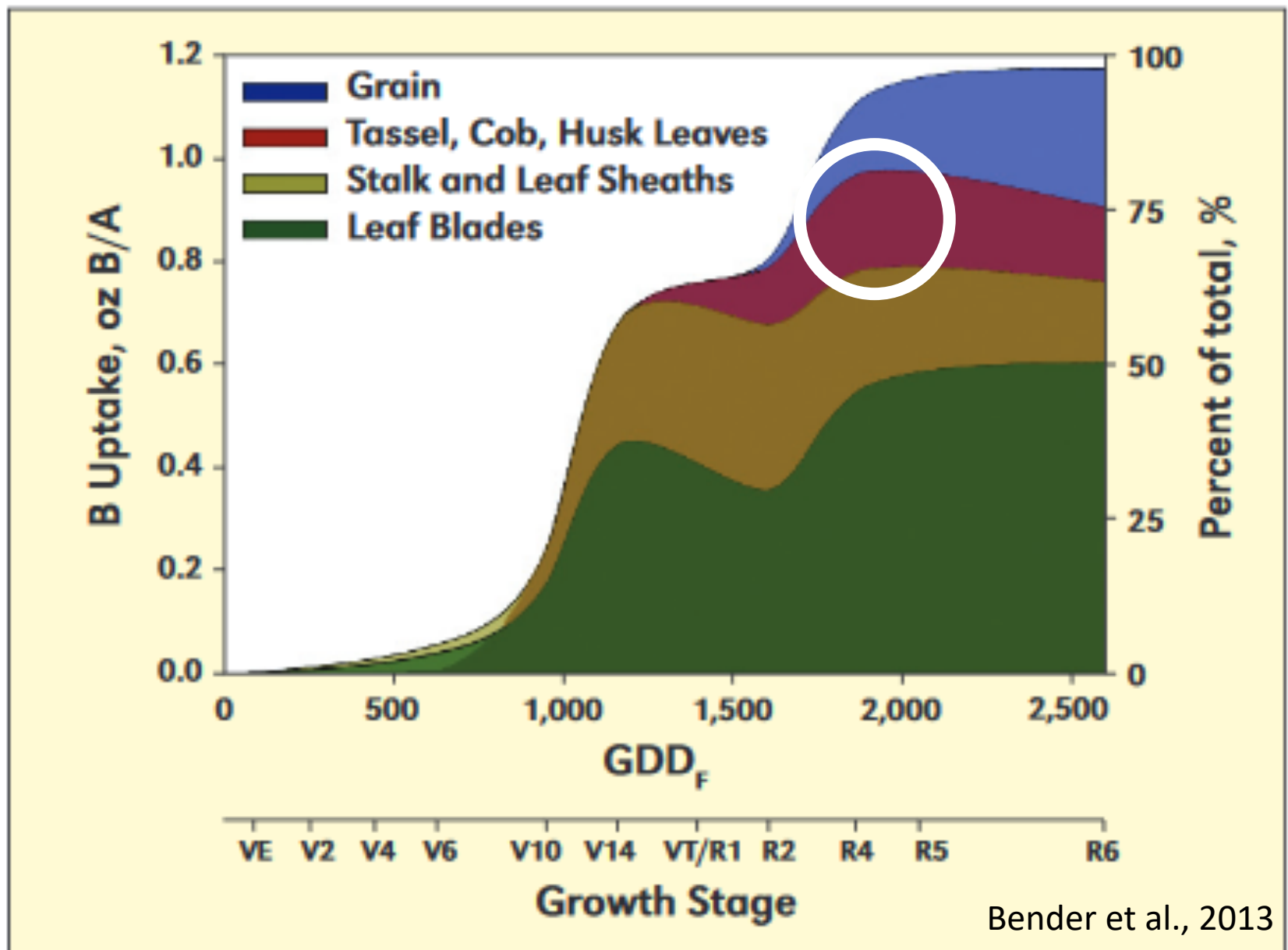
- Main source of B in soils is mineralization of B associated with soil organic matter
- Plants accumulate boric acid [H_3BO_3] and possibly borate [$\text{B}(\text{OH})_4^-$]
- Neither H_3BO_3 nor $\text{B}(\text{OH})_4^-$ are strongly attracted to soil particles so leaching losses are expected



Boron deficiency of corn

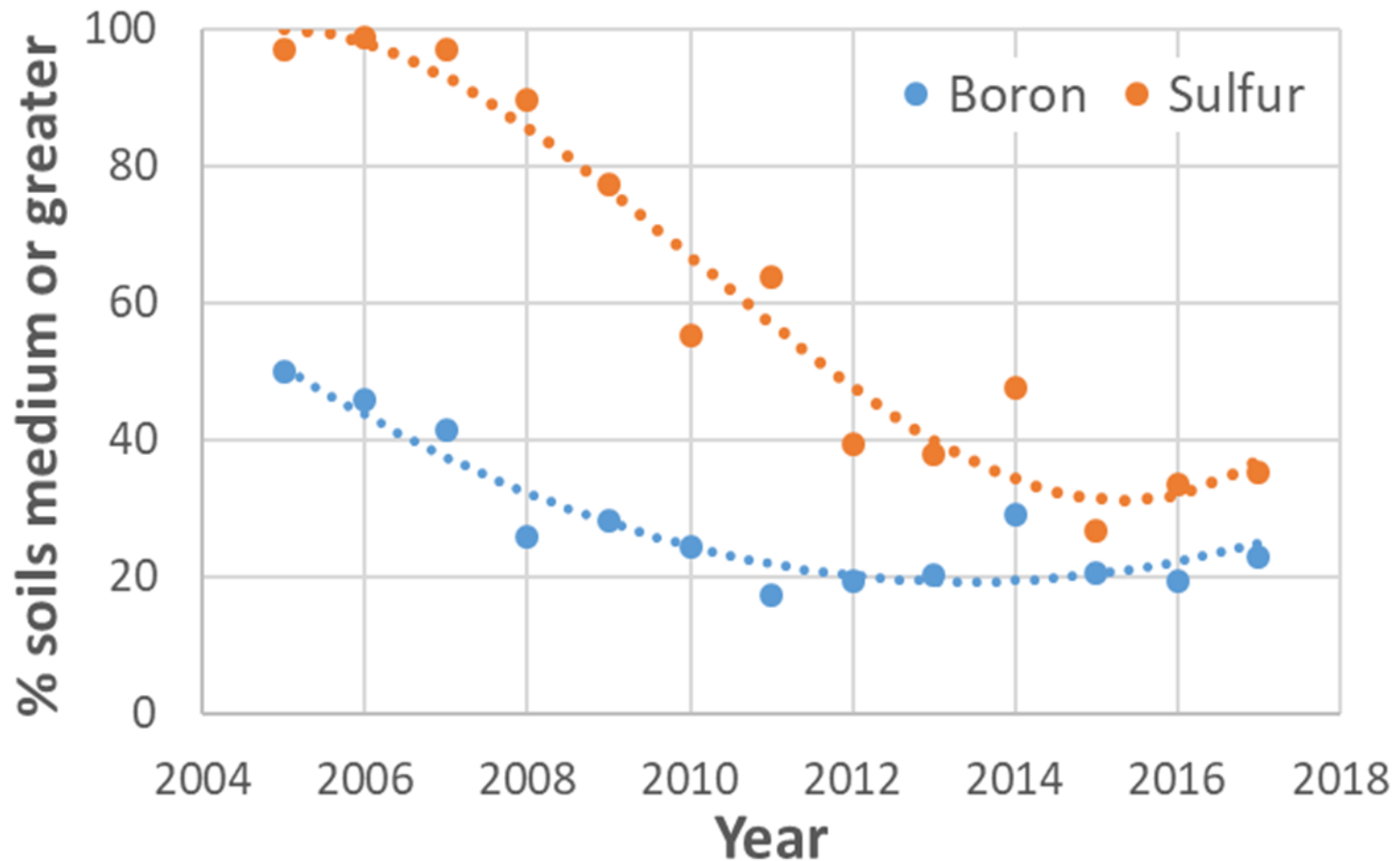
Earleaf tissue
boron $>4-10$
ppm is
adequate





Bender et al., 2013

% soils in adequate range decline

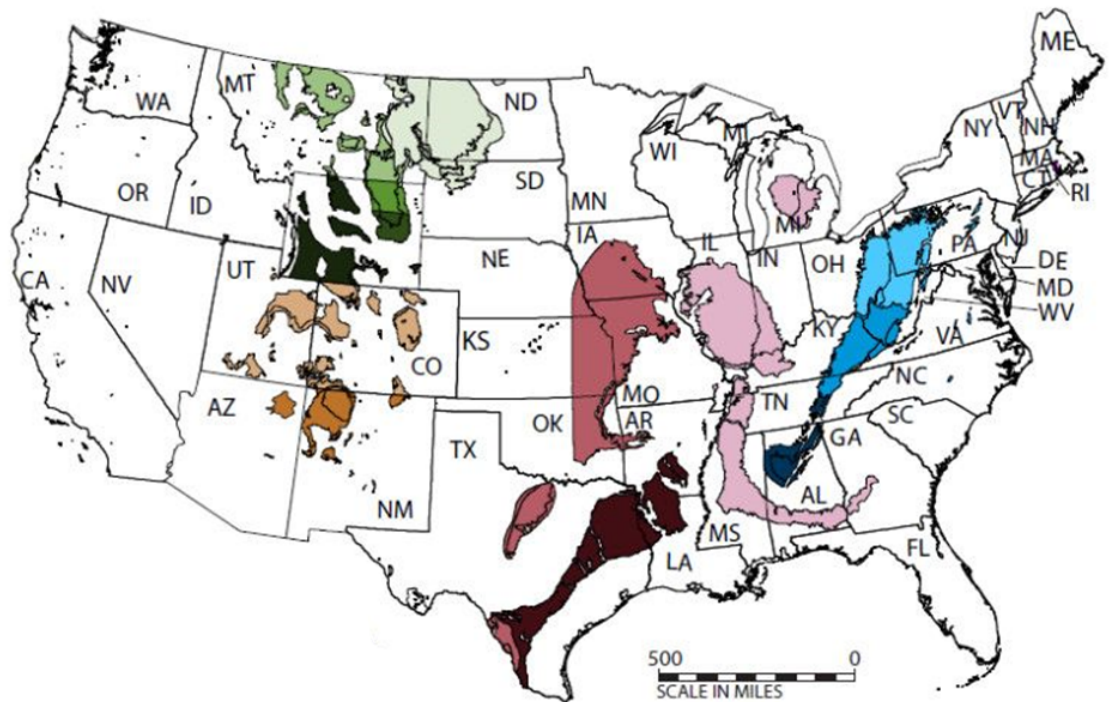


Boron content of coal

- 116 ppm - Great Plains
- 25 ppm - Appalachian Region
- 96 ppm - Eastern Interior
- Volatile emissions down from 30-70% to **5%**



webstockreview.net



U.S. Energy Information Administration

Mosaic marketing claim

“The Key to Maximizing Yield

Boron deficiency is widespread, affecting crop production and quality across North America.”

A tablet displaying the Mosaic Aspire Value Calculator interface. The screen shows a navigation menu with five items: 1 Crop, 2 Yield, 3 Rates, 4 Rates, and 5 Prices. A large green button labeled "PLAY VIDEO" is prominent. The text "HARNESS THE POWER OF BORON" is overlaid on the screen. Below the button, a paragraph states: "Aspire® combines two forms of boron with potassium in one granule for uniform nutrient distribution, season-long boron availability and maximum yield." The background of the tablet screen shows a person's hands holding a plant. The overall image is a promotional graphic for Mosaic's Aspire product.

Aspire

Mosaic | Value Calculator

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THE POWER OF BORON PERFORMANCE LOCATE A DEALER

HARNESS THE POWER OF BORON

PLAY VIDEO

Aspire® combines two forms of boron with potassium in one granule for uniform nutrient distribution, season-long boron availability and maximum yield.

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Kentucky, Russell Co., 2009 & 2010

Field	2009		2010	
	Leaf B, ppm	Yield, bu/a	Leaf B, ppm	Yield, bu/a
1	3.8 a	144 c	3.6 b	111 b
	5.3 a	162 c	13.5 a	164 a
2	4.3 b	147 cd	3.1 b	161 a
	6.3 a	160 bc	13.3 a	165 a

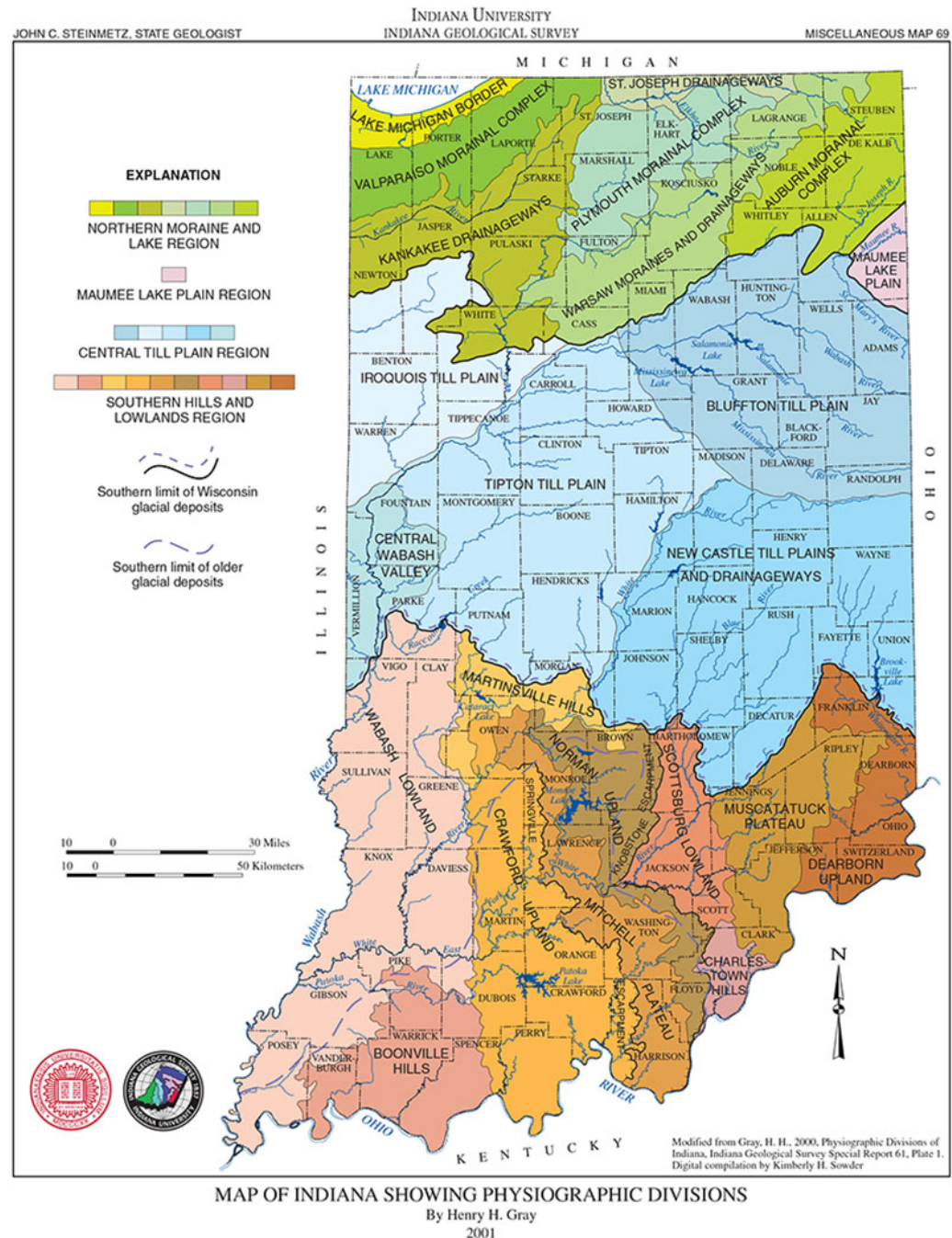
1 lb B/a in 2009 and 1.6 lb B/a in 2010.

Boron questions

- Is B availability sufficient for high yielding corn crops
- Are certain soils or regions more prone to B deficiency

“Generally boron deficiencies are confined to the sandy soils of northern Indiana and to the residual and oldest glacial soils of southern Indiana.”
Mengel, 1990

<https://www.extension.purdue.edu/extmedia/AY/AY-239.html>



Boron trials 2019

- Large plot at 7 locations
- B applied as Solubor at 0.2-0.5 lb B/acre in UAN/ATS at sidedress
- Tissue B of whole plant at V6 and earleaf at silking
- Grain yield, moisture, and grain B



Leaf tissue 2019, B-ppm

Location	V6	Earleaf	
		-B	+B
Blackford	n/a	6	7†
PPAC	4	6	6†,‡
SEPAC, F10	2	no trt.	2‡
SEPAC, G5	4	4	4†,‡
Shelby	4	5	7‡
SWPAC	8	6	6‡

†0.4 lb B/a; ‡0.2 lb B/a

Diana Salguero

Location	Boron, lb/a	Yield, bu/a	Moisture, %
Blackford	0	214	19.8*
	0.5	213	19.5
PPAC	0	176	20.1
	0.2	177	20.5*
	0.4	177	20.1
PPAC-Rice	0	193	19.2
	0.2	193	19.3
SEPAC	0	158	18.4
	0.2	157	18.1
	0.4	155	18.3
Shelby	0	218	21.4
	0.4	221	21.2
SWPAC Diana Salguero	0	173	15.5
	0.4	171	16.1*

Boron fertilizers

- Do not put boron with any seed under any circumstances!
- Boron has narrowest range between not enough and too much of any nutrient!
- Foliar boron can burn too!

Boron toxicity

1.1 lb B/acre soil-applied by mistake

Soil – 3.2 ppm

Tissue – 358 ppm



U.S. Borax – Rio-Tinto

- Granubor[®], Fertibor[®] - 15% B
 - Disodium tetraborate pentahydrate,
 $\text{Na}_2\text{B}_4\text{O}_7 \cdot 5\text{H}_2\text{O}$
- Solubor[®] - 20.5% B
 - Disodium octaborate tetrahydrate,
 $\text{Na}_2\text{B}_8\text{O}_{13} \cdot 4\text{H}_2\text{O}$

Our mine is the largest open pit mine in California and one of the richest borate deposits on the planet. While boron is present everywhere in the environment, substantial deposits of borates are relatively rare.

The U.S. Borax boron deposit produces primarily tincal and kernite, which are calcium-free sodium borates. This makes them optimal for use in agriculture.



Mosaic

- Aspire[®] - 58% K₂O, 0.5% B
 - Sodium borate is highly soluble
 - Calcium borate is slowly soluble, hydrated calcium borate hydroxide, CaB₃O₄(OH)₃·H₂O



Helena Agri-Enterprises



12-0-0

Plus 5% B

**CONTROLLED RELEASE NITROGEN PLUS BORON
NUTRITIONAL LIQUID CONCENTRATE**

GUARANTEED ANALYSIS

Total Nitrogen (N) 12.00%
 6.00% Urea Nitrogen
 6.00% Water Soluble Nitrogen*
Boron (B) 5.00%

Derived from borates, urea, methylene diurea and methylene ureas.
*6.00% Slowly Available Nitrogen from methylene diurea and methylene ureas.
1 gallon contains 0.5 pounds of elemental Boron (B) and 1.24 pounds of Nitrogen (N).

KEEP OUT OF REACH OF CHILDREN

WARNING

May be harmful if swallowed.
May be harmful in contact with skin.
Causes serious eye irritation.
Causes mild skin irritation.
May be harmful if inhaled.

Derived
from
borates



USE WITHIN 9 MONTHS OF DATE.

Contains **Boron**. Do not use on plants sensitive to **Boron**. Use of **Boron** on crops other than those recommended may result in serious injury to the crop.

WEIGHT PER GALLON: 10.6 lbs (4.81 kg)

NET CONTENTS:

SN 022615/0117G



25-0-0

Plus 0.5% B

**CONTROLLED RELEASE NITROGEN
FOLIAR FERTILIZER**

GUARANTEED ANALYSIS

Total Nitrogen (N) 25.00%
 18.8% Urea Nitrogen
 6.2% Other Water Soluble Nitrogen*
Boron (B) 0.50%

Derived from urea, methylene diurea, methylene ureas and boric acid.
Chlorine (Cl), not more than 0.01%.
*6.2% Slowly Available Nitrogen from methylene diurea and methylene ureas.

KEEP OUT OF REACH OF CHILDREN

WARNING

May be harmful if swallowed.
May be harmful in contact with skin.
May be harmful if inhaled.
Causes mild skin irritation.
Causes serious eye irritation.

Derived
from boric
acid



USE WITHIN 9 MONTHS OF DATE.

WARNING: Contains **Boron**. Do not use on plants sensitive to **Boron**. Use of **Boron** on crops other than those recommended may result in serious injury to the crop.

NET CONTENTS: ☐ 2.5 gals. (9.46 L)
☐ 250 gals. (946.25 L)
☐ Bulk _____

SN 0915/0816G

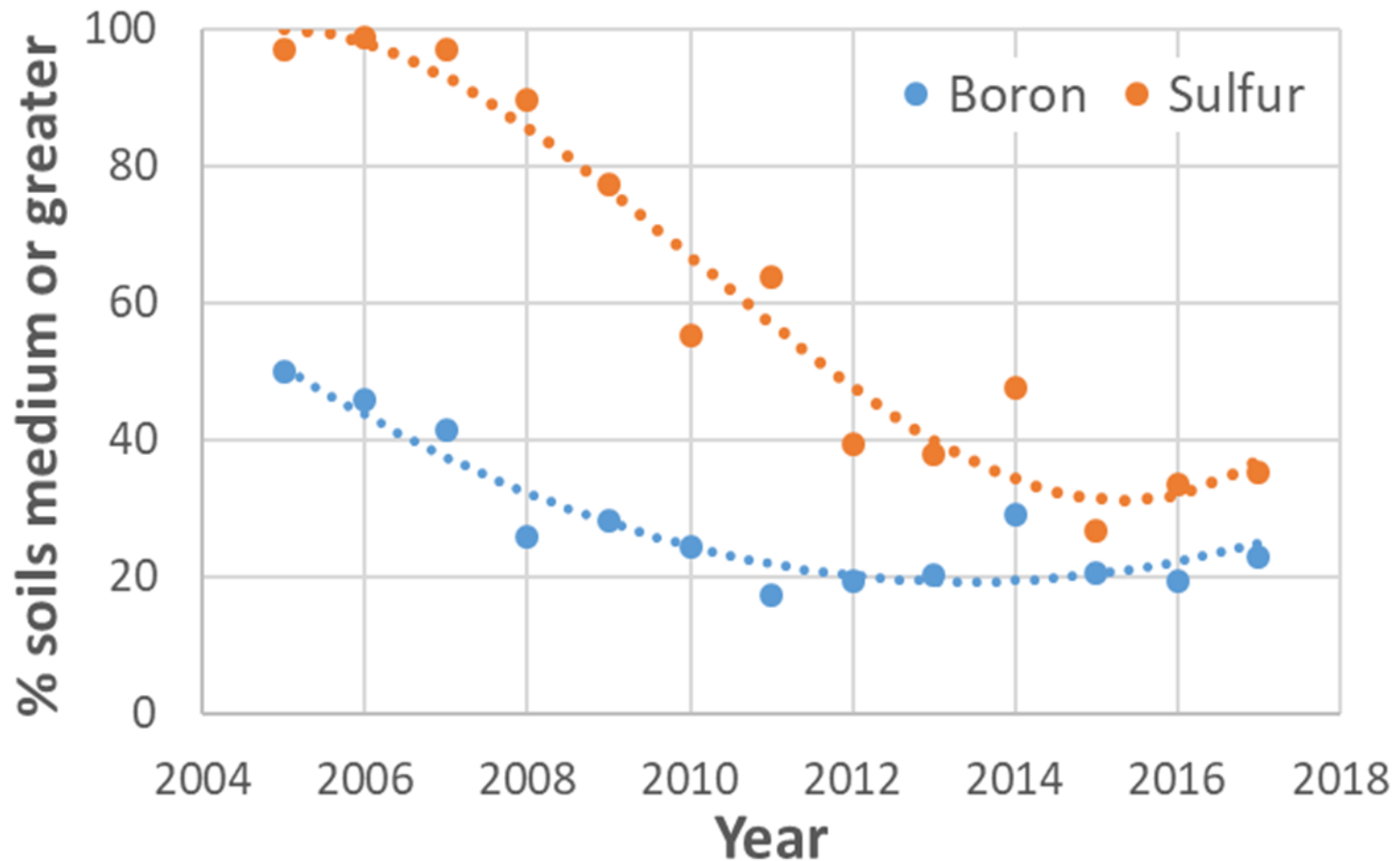
Questions remaining on B?

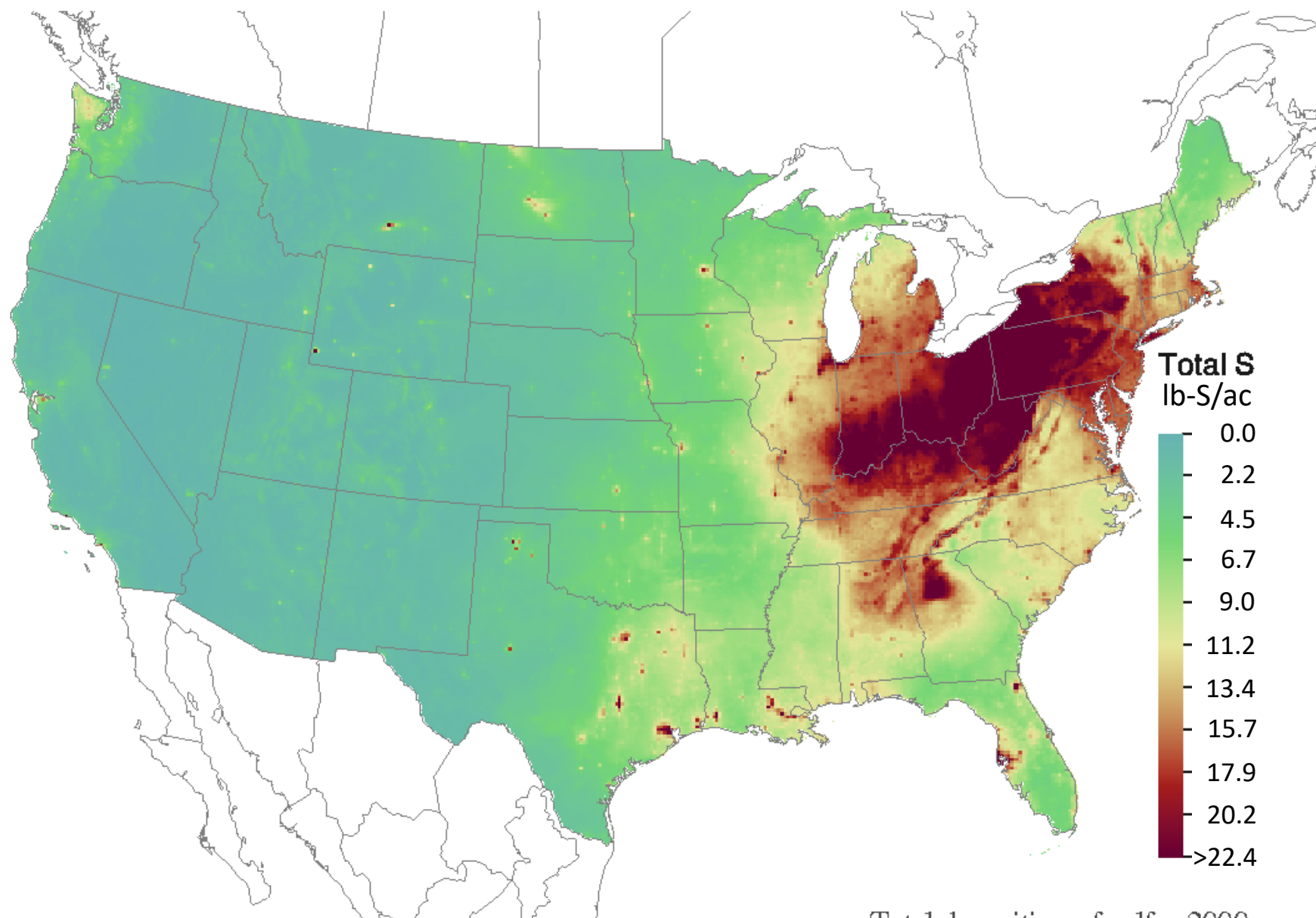
- What combination of weather, soil, and cropping conditions result in low B availability to crops?
- With low tissue B what is the frequency and magnitude of crop response to B?
- What fertilizer source of B is best if a profitable response to B warrants fertilization?

Update on corn response to sulfur



% soils in adequate range decline

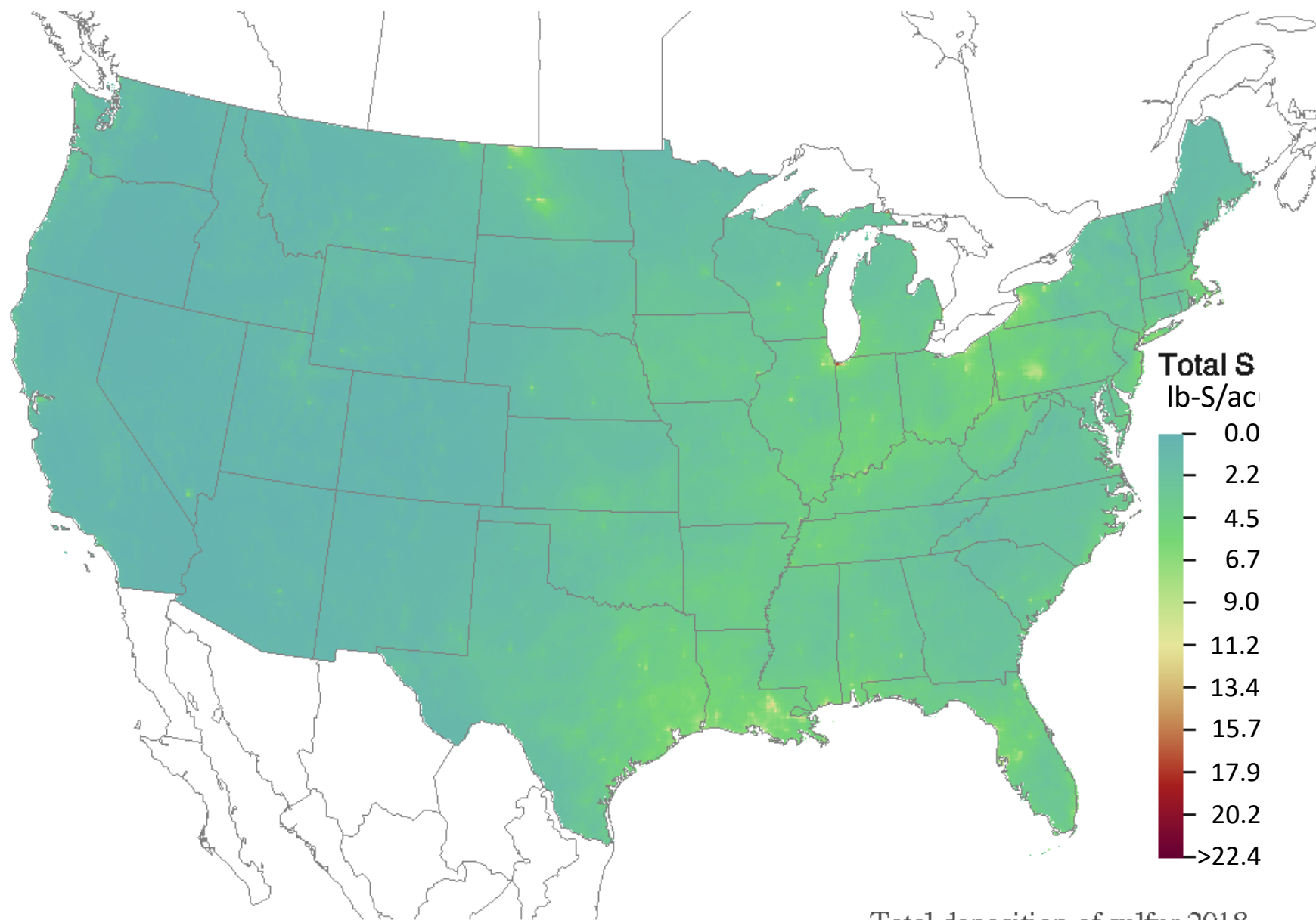




Total deposition of sulfur 2000

Source: CASTNET/CMAQ/NADP

USEPA 08/28/18



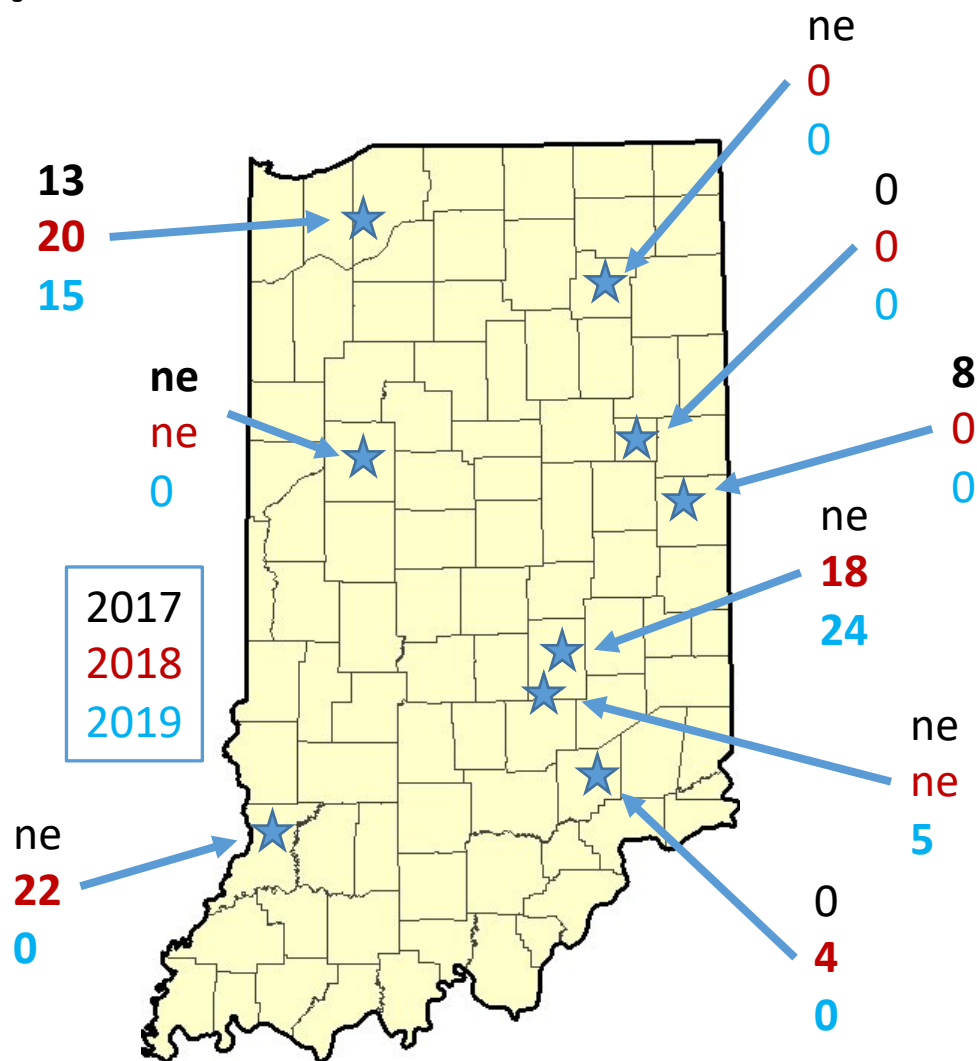
Total deposition of sulfur 2018

Source: CASTNET/CMAQ/NADP

USEPA 10/21/19

Corn yield response to S

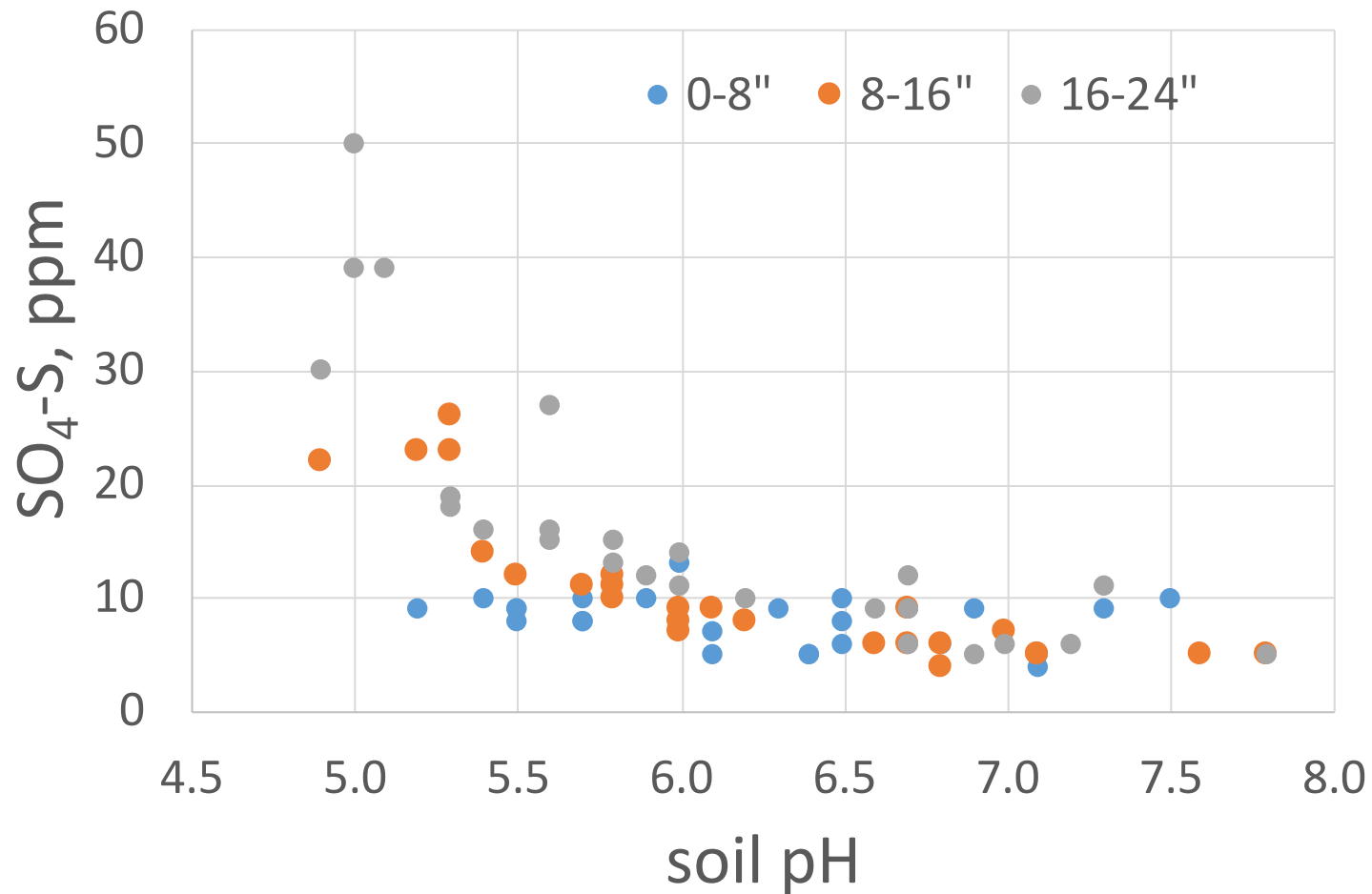
- Sulfur application increased yield in 9 of 19 trials
- The lowest rate of S in each trial was sufficient (7.5-15 lb/acre)



Distribution of sulfate-S in soil

Depth	ACRE	DPAC	NEPAC	PPAC	SEPAC	TPAC
inches	----- mg SO ₄ -S/kg -----					
0-8	6±1	6±1	10±1	5±1	7±2	7±1
8-16	4±1	4±0	6±1	3±1	12±4	6±2
16-24	3±1	4±1	5±1	3±1	19±7	7±2

Relationship between pH and $\text{SO}_4\text{-S}$ for SEPAC with depth



Phosphorus fertilizer as a source of sulfur

- MAP (11-52-0, 64 samples)
1.3-2.4% S
 - @75 lb P_2O_5 /ac applies **1.9-3.5 lb S/ac (avg. 2.6)**
- DAP (18-46-0, 53 samples)
1.4-3.3% S
 - @75 lb P_2O_5 /ac applies **2.2-5.5 lb S/ac (avg. 3.0)**

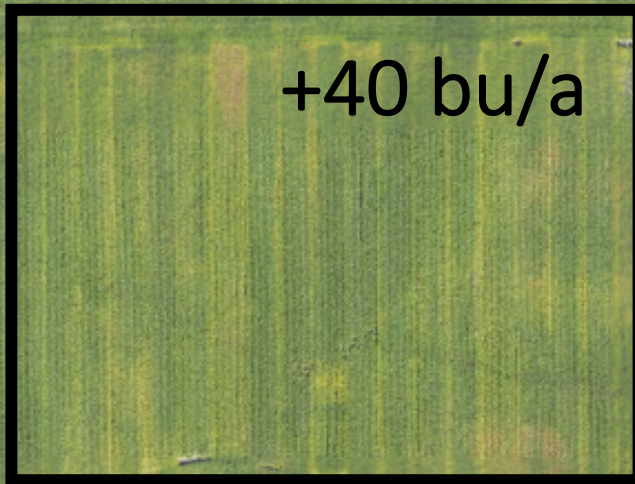
Data thanks to:



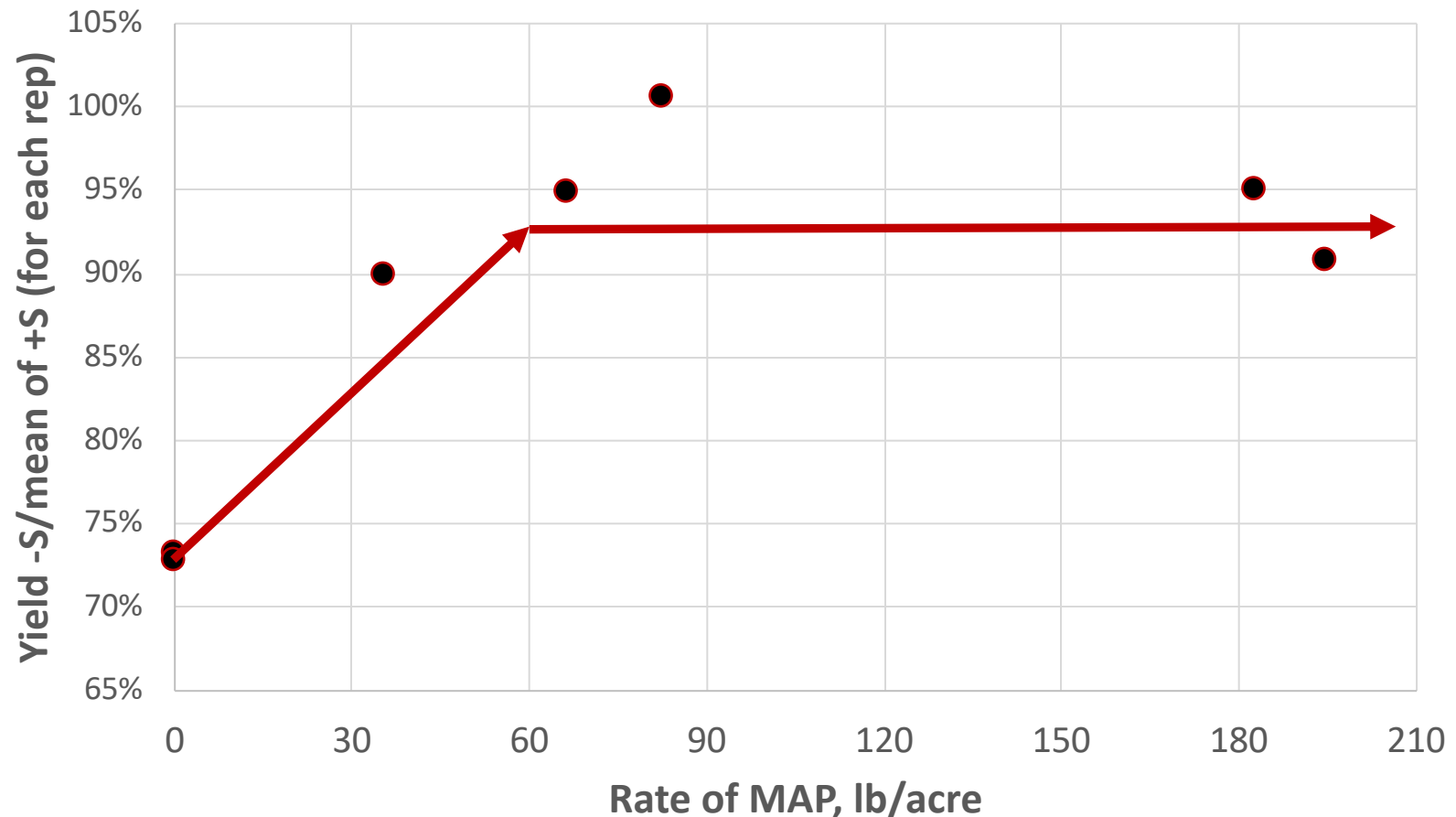
Office of Indiana
State Chemist

NI Ranch, IL

NI County Road 500 E



Does fall-applied P fertilizer contribute S to the next corn crop?



Important questions?

- Frequency and magnitude of responses as a function of soil properties and management practices
- Contribution of subsoil S and irrigation water in some regions
- Sulfur availability of purposeful and incidental applications of S in fall and winter