AGVISE Demonstration Projects Update

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AGVISE Demonstration Projects

- The Why?
- Past Demo Projects
  - Drain Tile for Saline and Sodic Soils
  - Adding Elemental Sulfur and Gypsum on Saline Soils, Sodic Soils, High pH soils
  - Liming Acidic Soils in No-Till Systems
  - Soybean Cyst Nematode (SCN) Resistance Project
  - Building Soil Test P on Troublesome High pH Soils
  - Changing Base Saturation Cation Ratios (or not…)

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Project Update: Can You Lower Soil pH by Applying Elemental Sulfur

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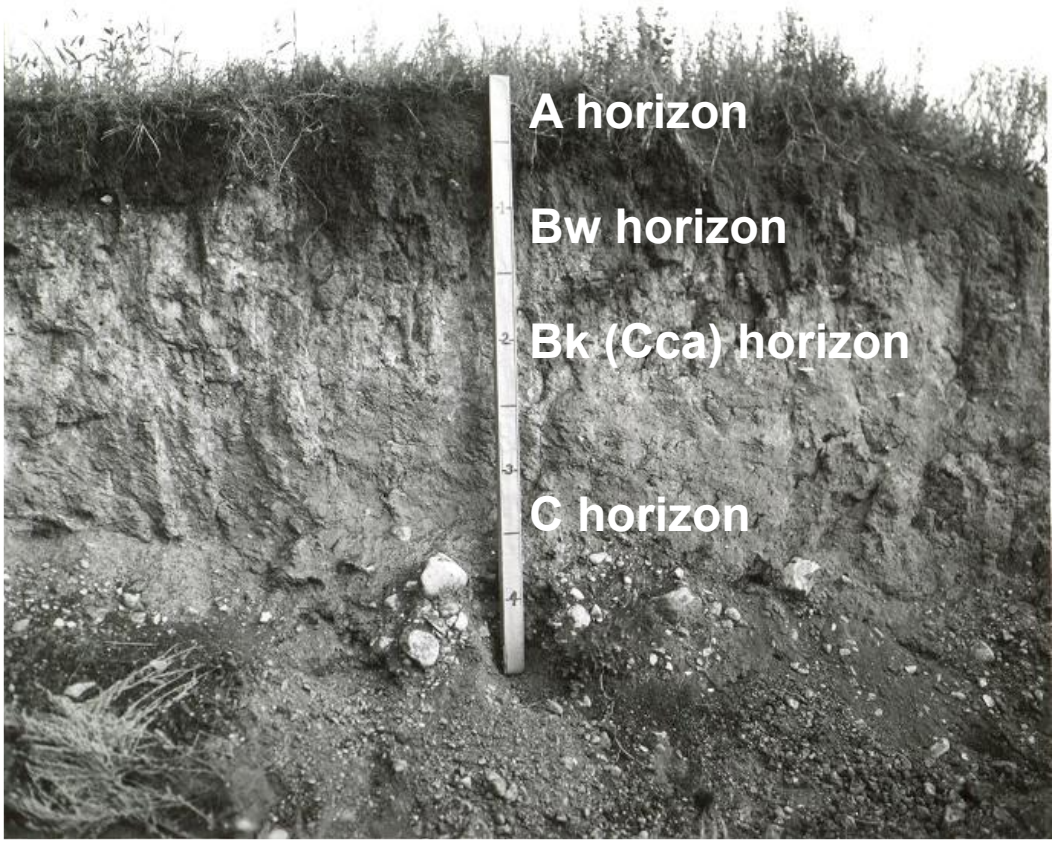
What is calcium carbonate ($CaCO_3$, free lime)?

- Insoluble
- Naturally occurring
- “Whitish” color to soil

  Subsoil
- Calcic (Bk or Cca)

  horizon
- Present since glaciation
- Groundwater
- Eroded Hill Tops
- Tillage Erosion



From historical photograph collection of D.G. Hopkins, North Dakota State Univ., Fargo, ND.

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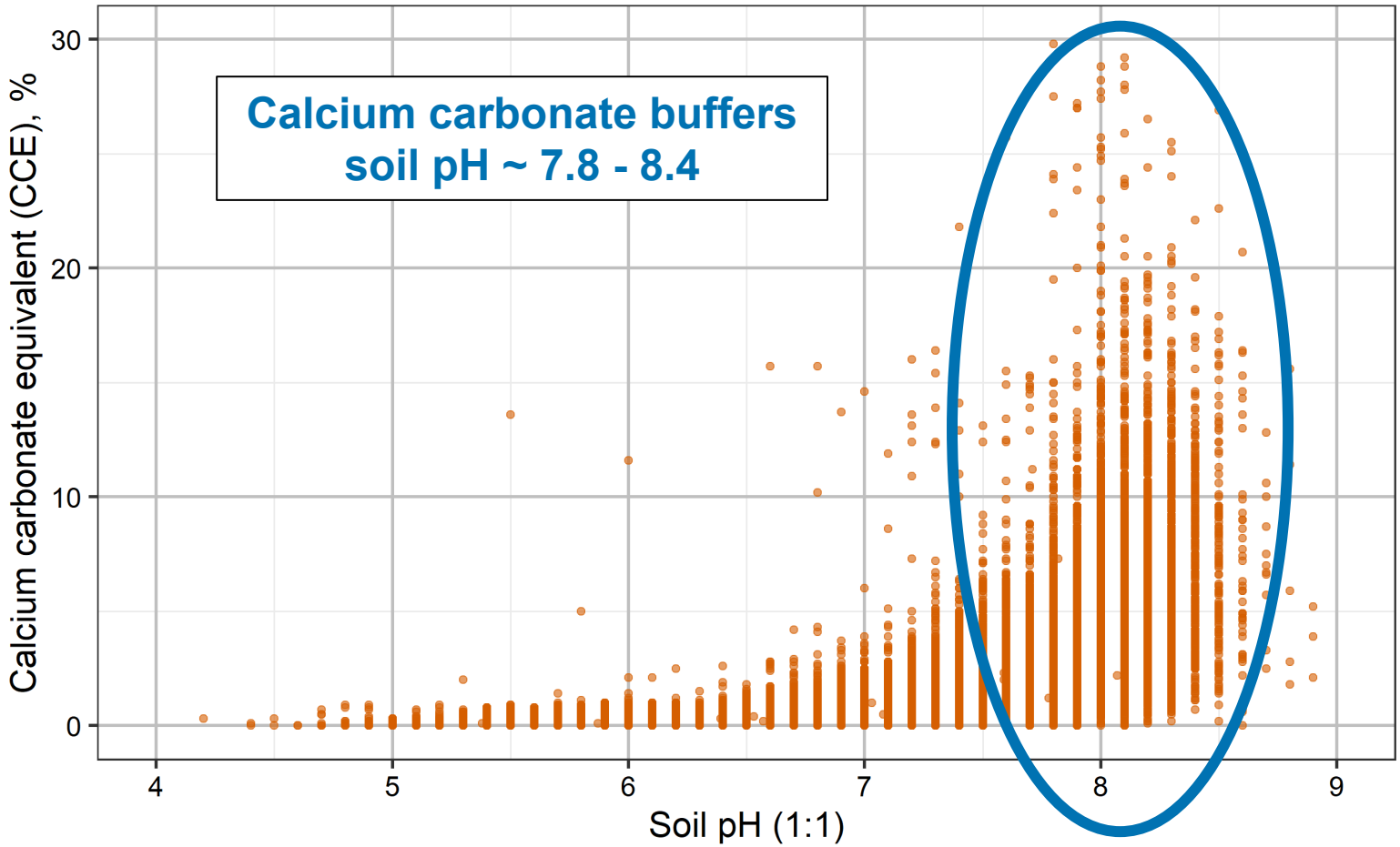
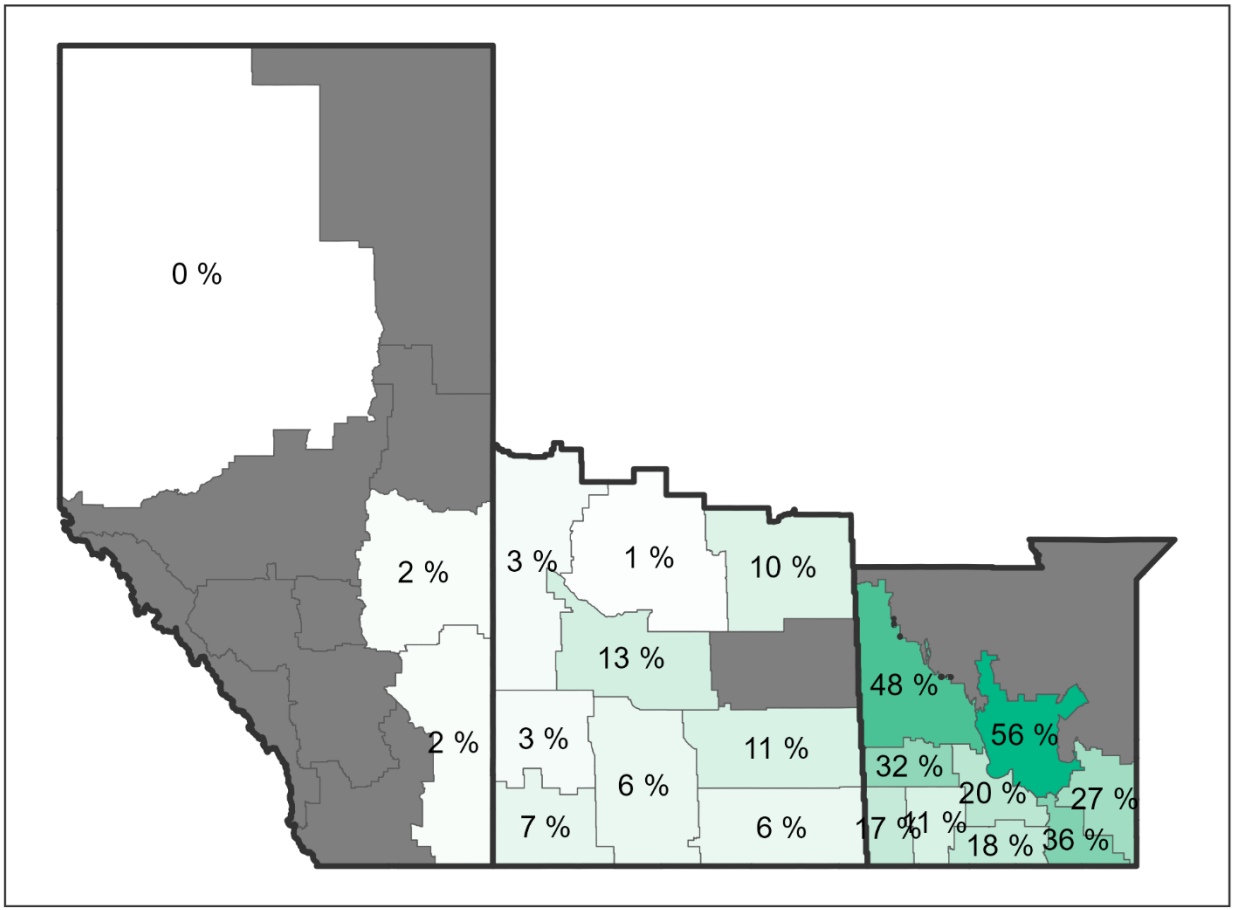
Calcium carbonate (free lime) controls and buffers high soil pH

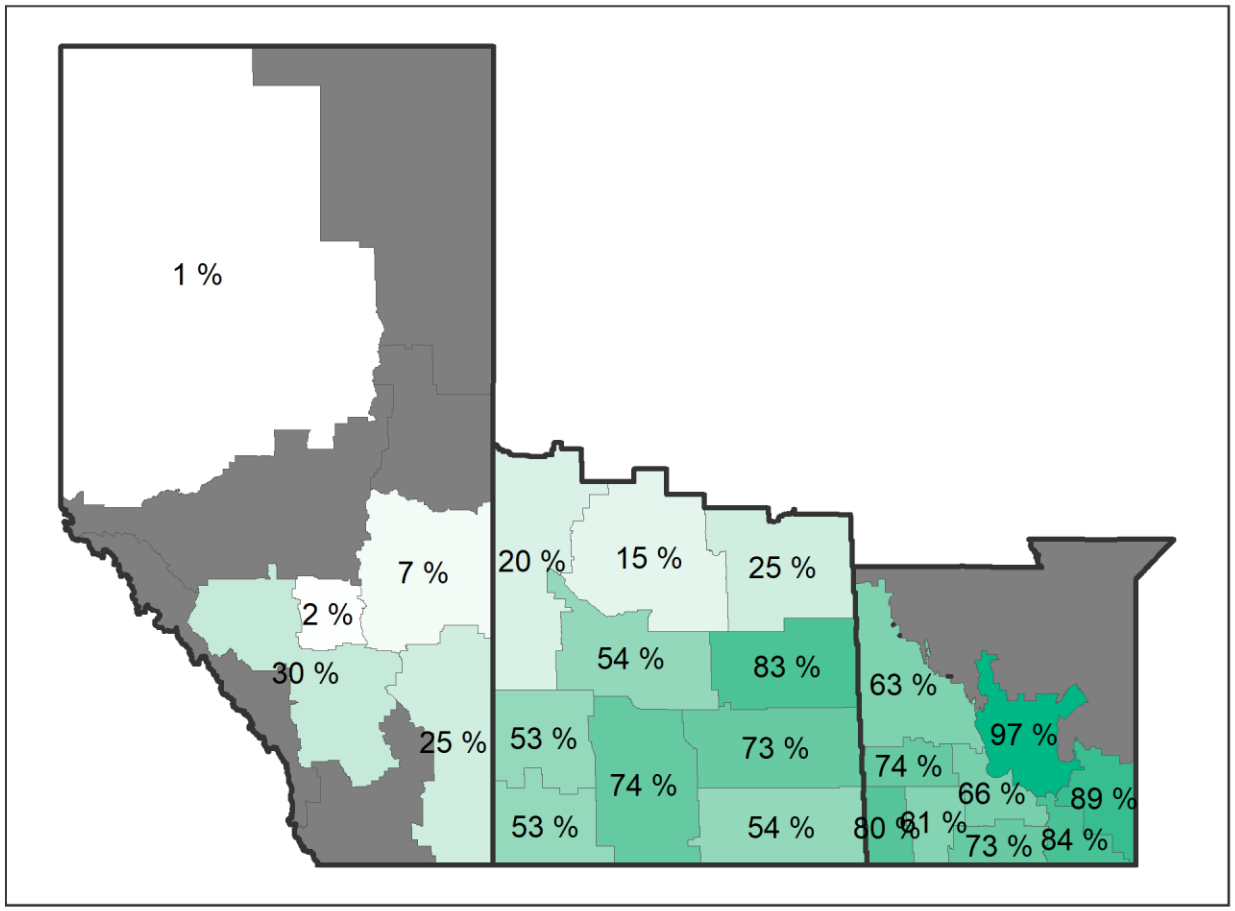


Soil samples with calcium carbonate above 5.0 % CCE in 2025



Data not shown where n< 100
AGVISE Laboratories, Inc.

Soil samples with soil pH above 7.3 in 2024



Any soil with pH > 7.3 will contain some calcium carbonate

Percent of samples (0-6 inch)

75

50

25

Data not shown where n< 100
AGVISE Laboratories, Inc.

Soil pH increasing? Stop soil erosion!

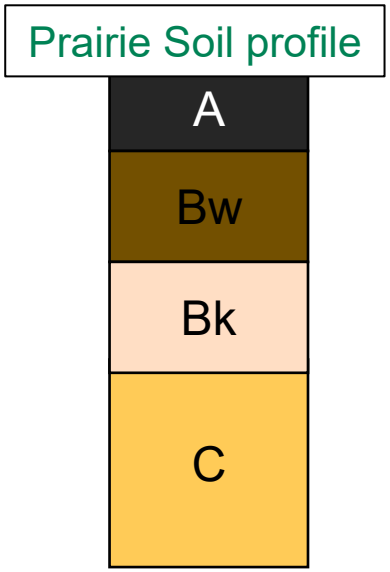
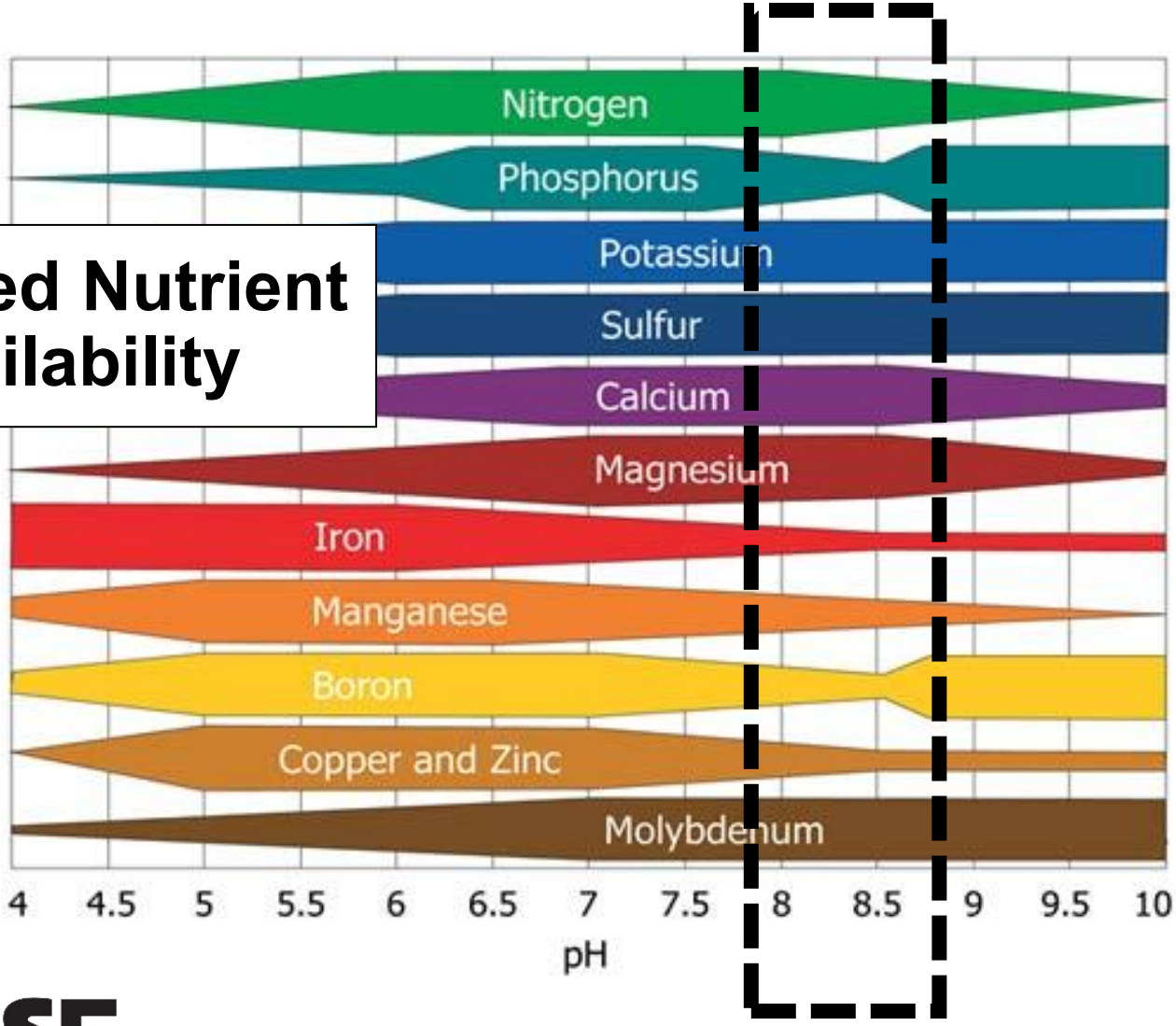


Photo from Bohn, M., D. Hopkins, C. Gasch, D. Steele, and S. Tuscherer. 2018. Predicting soil health and function using remote-sensed evapotranspiration and terrain attributes for a benchmark soil. In: Franzen, D.W., chair, 2018 NDSU Soil and Soil Water Workshop, Fargo, ND. 17 Jan. 2018. North Dakota State Univ., Fargo, ND.

What's the Problem?

Reduced Nutrient Availability



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How easily can you lower soil pH?

- Calcium Carbonate
  - Buffers soil pH
  - pH ~ 7.8 - 8.2
- Acidity
  - “Neutralize” the carbonate
  - Lower soil pH

Iron deficiency chlorosis

Sources of Acidity

- Rainfall (pH 5.0-5.5)
- Crop removal
  - Ca^{2+}, Mg^{2+}, K^{+}
- Nitrogen fertilizers
  - Nitrification ($NH_4^+ \rightarrow NO_3^-$)
- Elemental sulfur fertilizers
  - Sulfur oxidation ($S^0 \rightarrow SO_4^{2-}$)
- Aluminum or iron(II) sulfate fertilizers
- Phosphorus fertilizers containing elemental sulfur

PURDUE UNIVERSITY

PURDUE EXTENSION

HO-241-W

Commercial Greenhouse and Nursery Production

Lowering Soil pH for Horticulture Crops

Purdue Horticulture and Landscape Architecture
www.ag.purdue.edu/HLA
Purdue Agronomy
www.ag.purdue.edu/AGRY

Michael V. Mickelbart and Kelly M. Stanton, Purdue Horticulture and Landscape Architecture

Steve Hawkins and James Camberato, Purdue Agronomy

EXPERT REVIEWED

The pH scale measures the acidity or alkalinity of a solution. The scale extends from 0 (a very strong acid) to 14 (a very strong base or highly alkaline). The middle of the scale, 7, is neutral, neither acidic nor basic. Soil pH is important because it affects the availability of nutrients in the rooting zone.

Table 3. *Approximate amount of elemental sulfur needed to lower soil pH of a silt loam soil to a depth of 6 inches.*[1]

Present Soil pH	Desired Soil pH				
	6.5	6.0	5.5	5.0	4.5
	Pounds Elemental Sulfur per 100 Square Feet				
8.0	3.0	4.0	5.5	7.0	8.0
7.5	2.0	3.5	4.5	6.0	7.0
7.0	1.0	2.0	3.5	5.0	6.0
6.5	—	1.0	2.5	4.0	4.5
6.0	—	—	1.0	2.5	3.5

[1]For sandy soils, reduce amount by 1/3; for clay soils, increase amount by 1/2; if aluminum sulfate is used, multiply by 6.

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MICHIGAN STATE UNIVERSITY | Extension

Courtesy of MSU Extension.
For additional information, visit news.msue.msu.edu.

Lowering the Soil pH with Sulfur.

Mark Longstroth, Extension Small Fruit Educator

Blueberries prefer acid soils with a pH of 4.5 to 5.5. With the popularity of blueberries many people are interested in quickly adjusting their soil pH. Acidifying soil is not an exact science; this handout is just a guide. The cheapest way to lower the soil pH is to add elemental sulfur to the soil. Soil bacteria change the sulfur to sulfuric acid, lowering the soil pH.

If the soil pH is greater than 5.5, apply elemental sulfur (**S**) to decrease the soil pH to 4.5 (see Table 1). Spring application and incorporation work best. Soil bacteria convert the sulfur to sulfuric acid lowering the soil pH. It is important to note that this is a biological process (slow) and not a chemical reaction (rapid). The bacteria are active, when the soil is moist and warm. The soil temperature needs to be above 55F. The bacteria are not active in the winter so fall applications of sulfur have little effect on the soil pH next spring. In addition, the soil must not be saturated, or flooded (anaerobic) or the sulfur is converted to hydrogen sulfide (rotten egg smell) by anaerobic bacteria. Hydrogen sulfide kills plant roots. Irrigate to maintain soil moisture but do not over irrigate the soil. This causes flooding and anaerobic conditions. Most Michigan irrigation water is high in alkalinity (dissolved lime) and will gradually raise the soil pH.

Table 1. Elemental sulfur[1] needed to lower pH to 4.5 (lb./acre)

	Soil type		
Current pH	Sand	Loam	Clay
5.0	175	530	800
5.5	350	1030	1600
6.0	530	1540	2300
6.5	660	2020	3030
7.0	840	2560	3830

[1]To substitute ferrous sulfate, multiply by 8.

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The science behind lowering pH with elemental sulfur

- Soil applied S^0 oxidized by soil bacteria (*Thiobacillus*).

$$2S + 3O_2 + 2H_2O \rightarrow 2H_2SO_4$$

sulfur *oxygen* *water* *sulfuric acid*

- Sulfuric acid produces H^+ ions
- Sulfate sources (e.g. gypsum) do not create sulfuric acid
- **1% CCE = 6,400 lb/acre elemental S**

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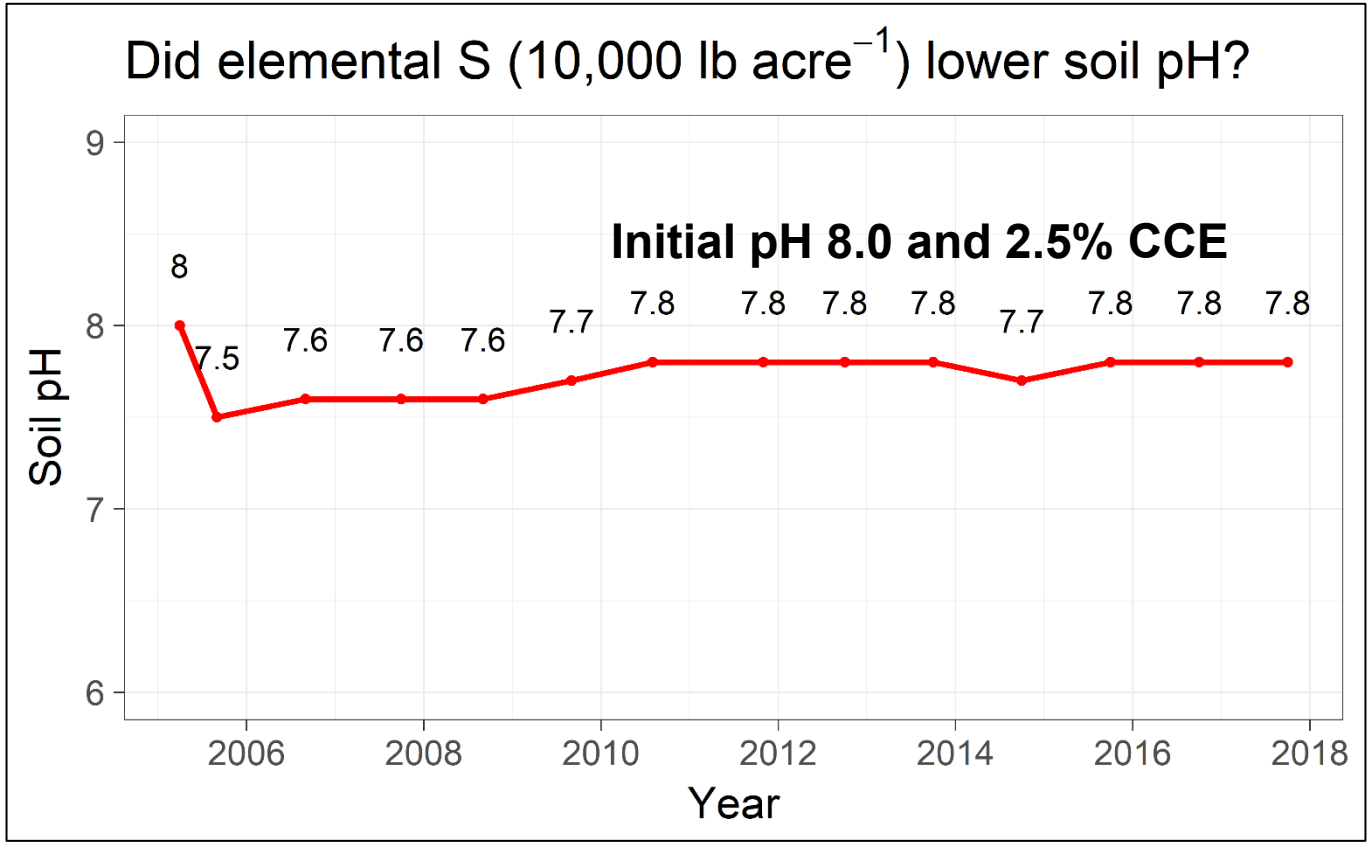
So like…..100 lb/A elemental sulfur, right?

AGVISE Demonstration 2005-2017



2020 Elemental Sulfur Demo

0 - 40,000 lb/acre

- Soil pH 8.0
- 4.5% CCE
- 6 inches
- Alfalfa

It takes about 3.2 tons elemental sulfur/acre to neutralize 1% CCE in soil

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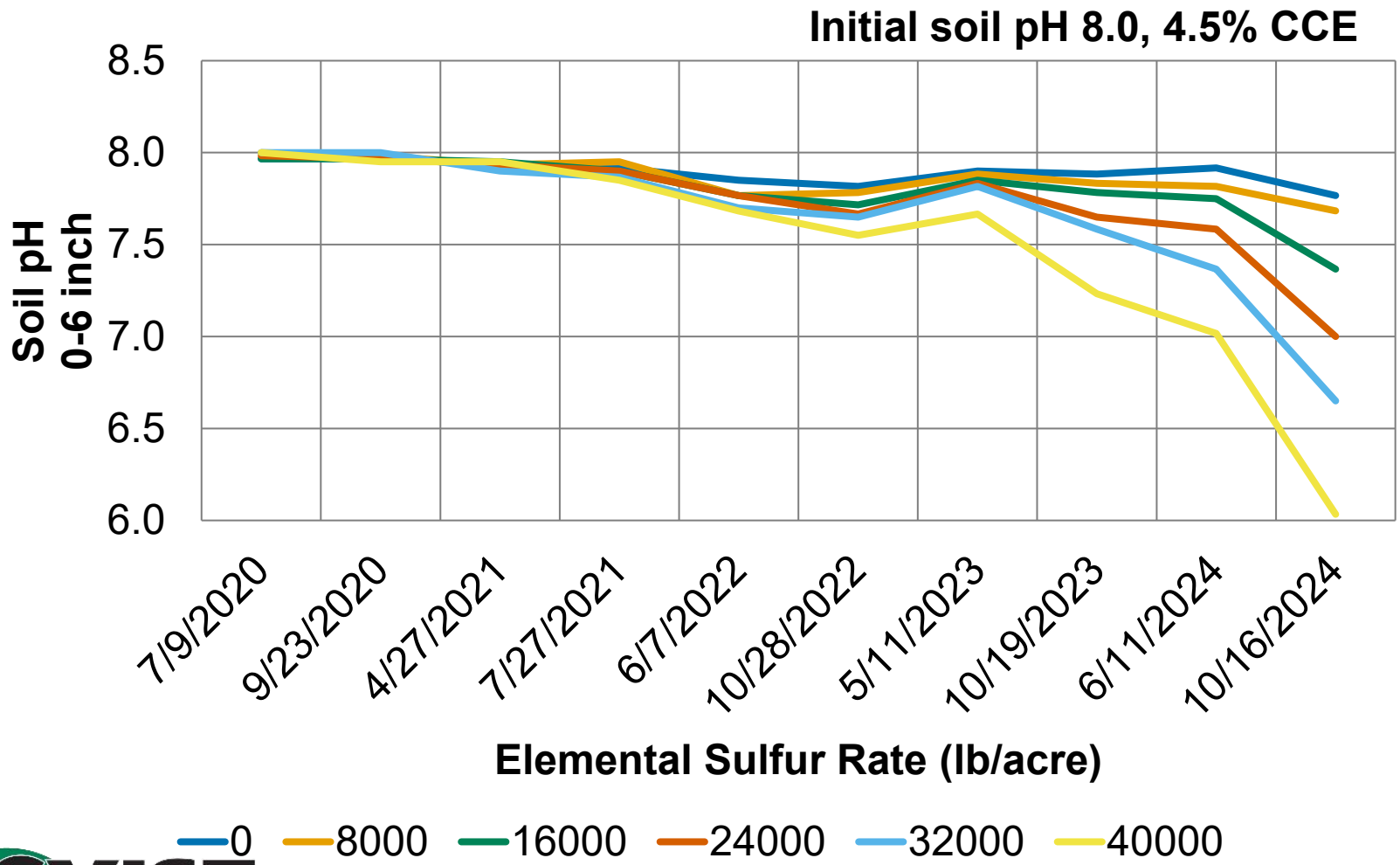
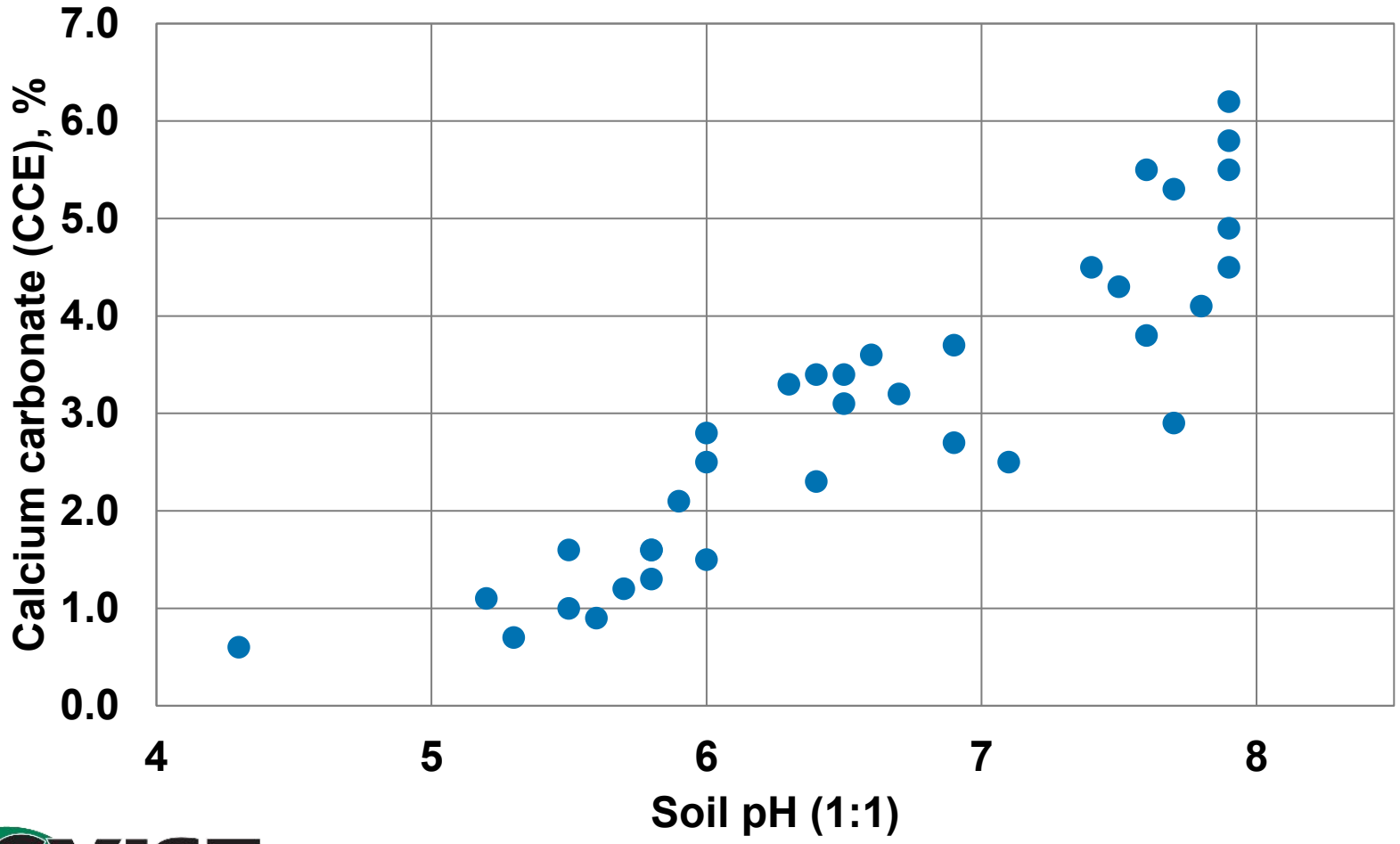
Elemental sulfur and soil pH



Results: pH and CCE



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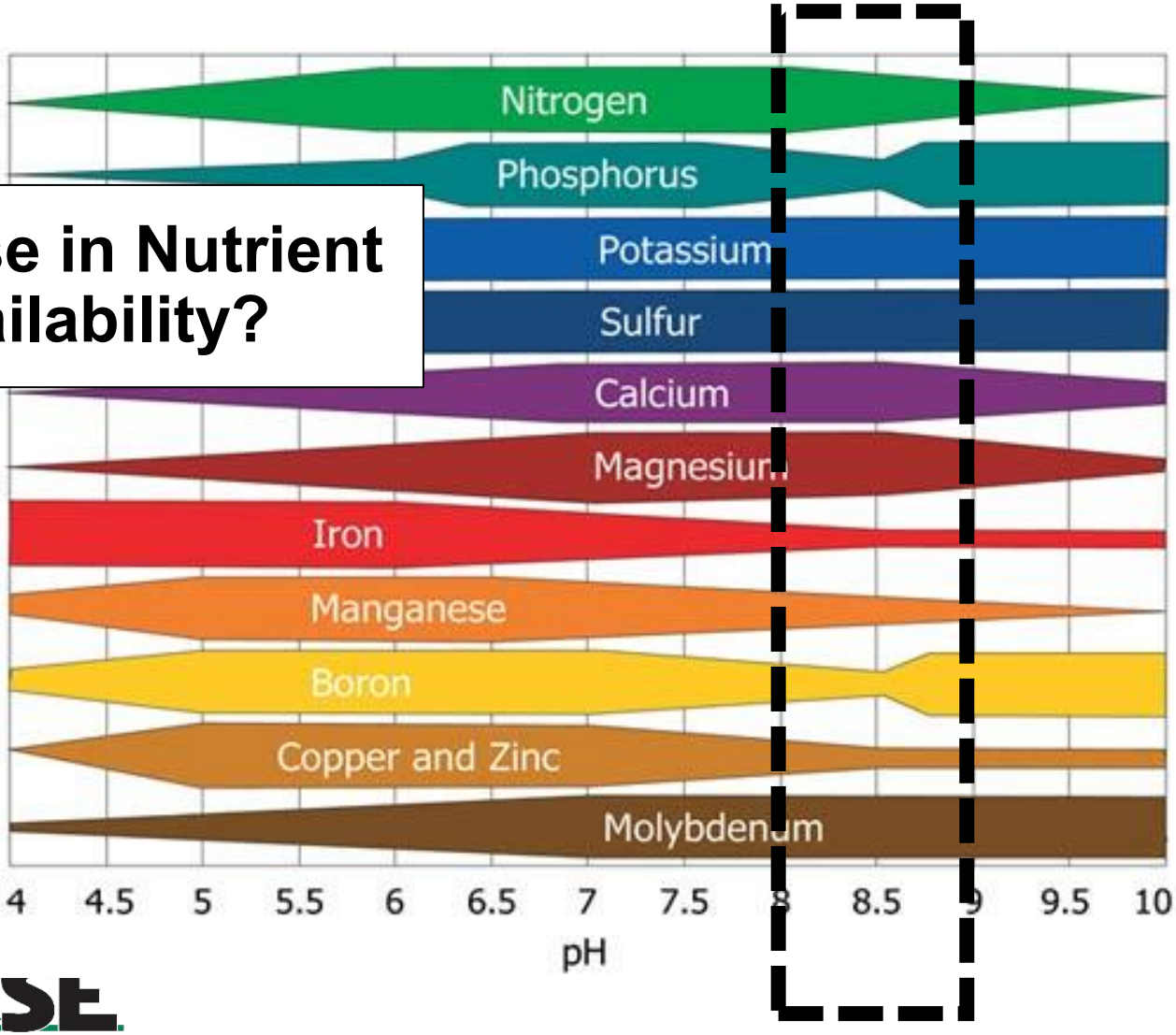
Is There Other Evidence?

Increase in Nutrient Availability?



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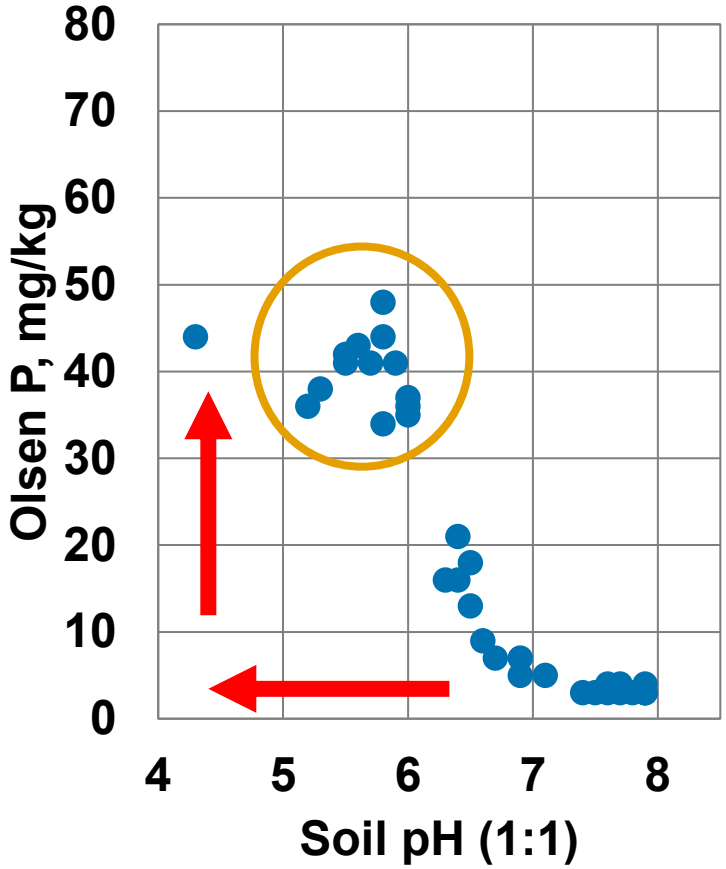
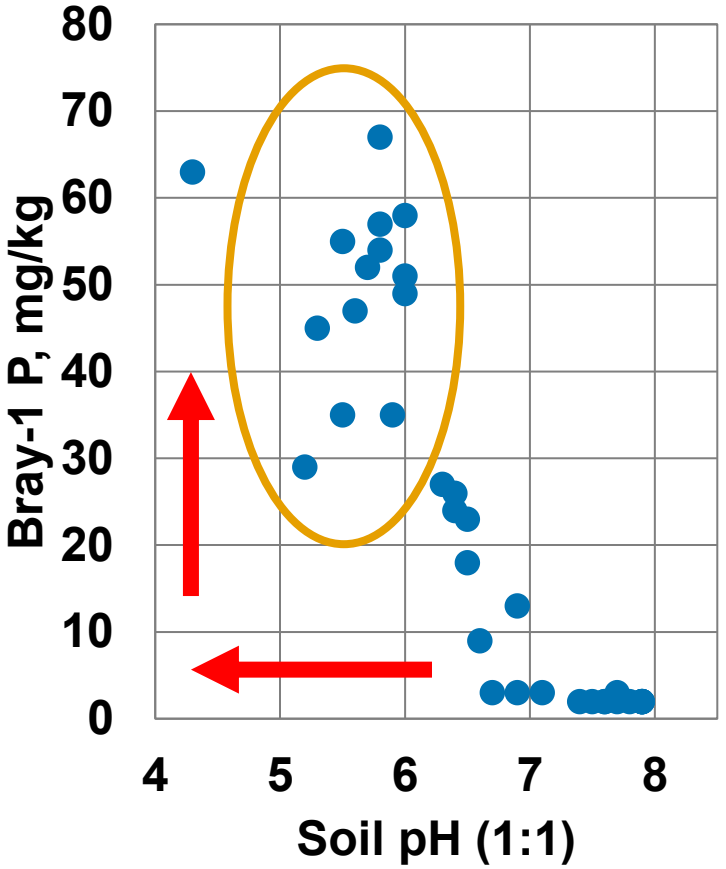
pH and Phosphorus Availability





Background Olsen P 4 ppm; Bray-1 P failed at pH < 6.5

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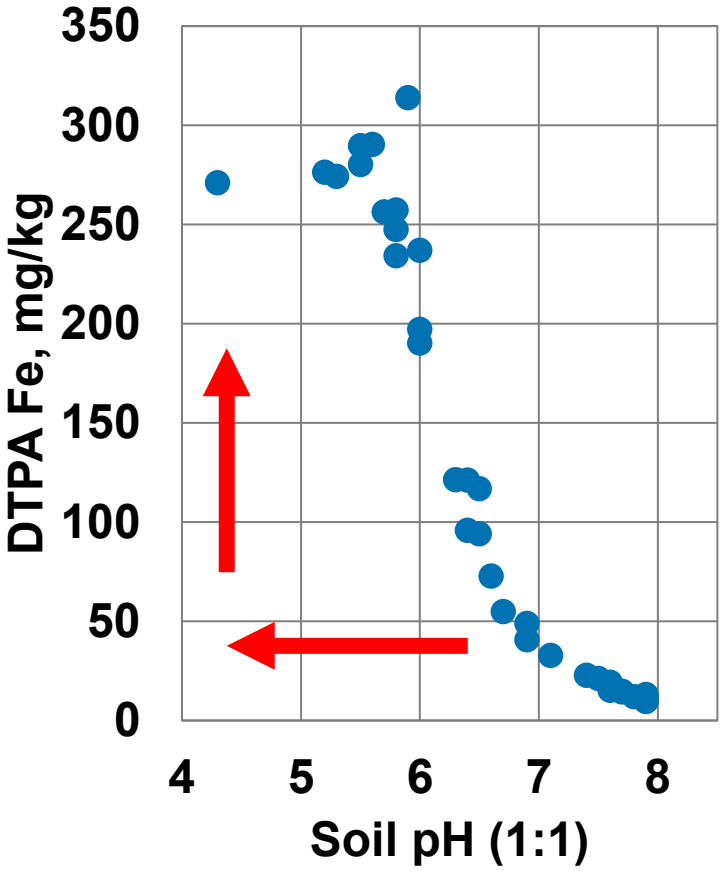
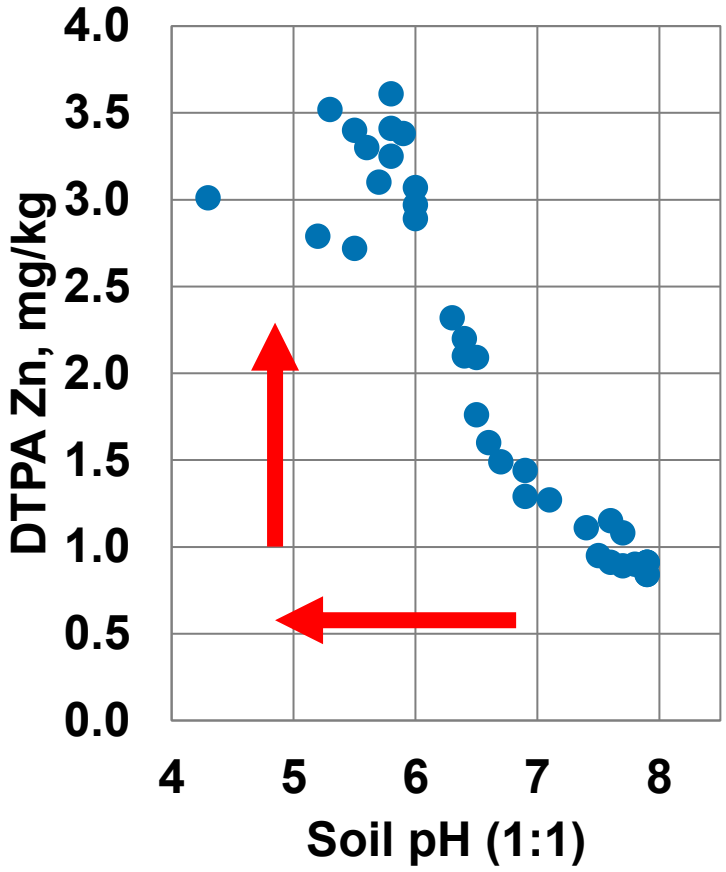
pH and Fe and Zn Availability





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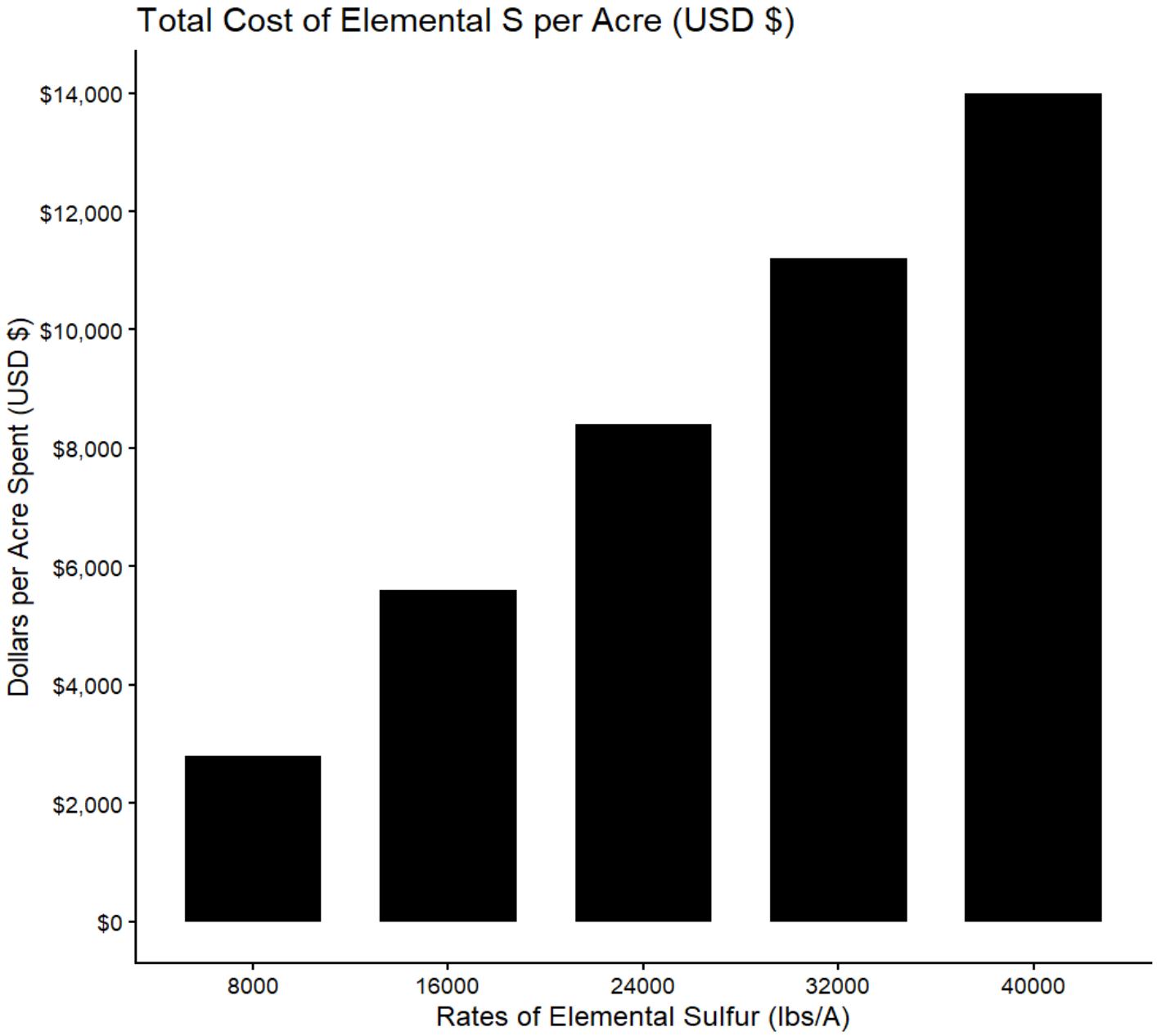
So…but it works right…?



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Fancy Math

- $19,000 CAD for 40,000 lb/acre elemental S
- pH 8 → pH 5.8
- 4 ppm → 40 ppm Olsen P
- MAP $1200 CAD/metric tonne
- 90 bu/acre wheat
  - P rate: 120 lb P_2O_5/acre broadcast if 4 ppm → 15 lb P_2O_5 (starter) if 40 ppm
- Lowering soil pH saved $110 CAD/acre in annual P application
- Elemental S paid off in → **172 years**
- **An over simplification but still…**

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So your saying there is a chance…

1967

Martian Farmer with a pH problem?

Possible Answers to Grower Questions

- Elemental Sulfur
  - The science works
  - Sulfuric acid neutralizes CCE = lower pH
  - Not Quick or Cheap
  - No easy solution to reducing soil pH in the northern Great Plains/Prairie Provinces

Your Questions?