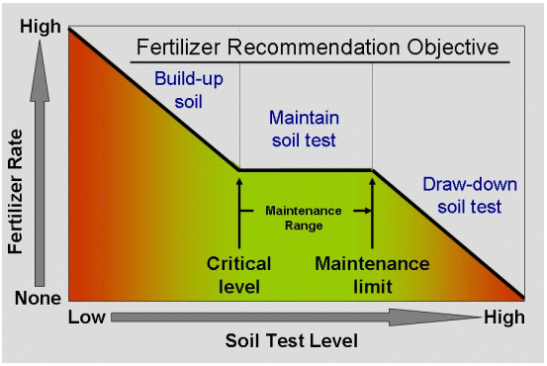
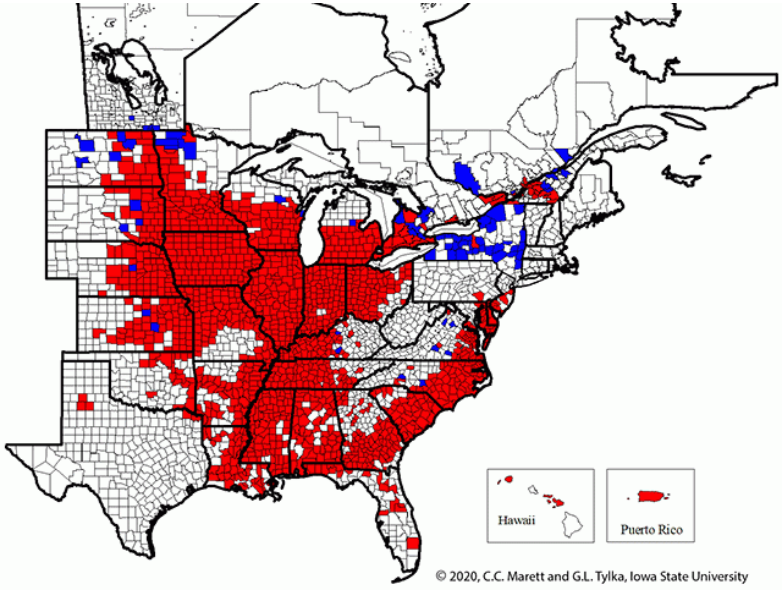
AGVISE Demonstration Project Update



Vitosh et al. (1995)



- Agvise Seminars
- January 6-8, 2026
- Brent Jaenisch, Ph.D.

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Outline

- Increasing soil test P values
- Decreasing soil pH with elemental sulfur
- 2025 SCN egg counts
- Agvisor V1 and V2
- Summary

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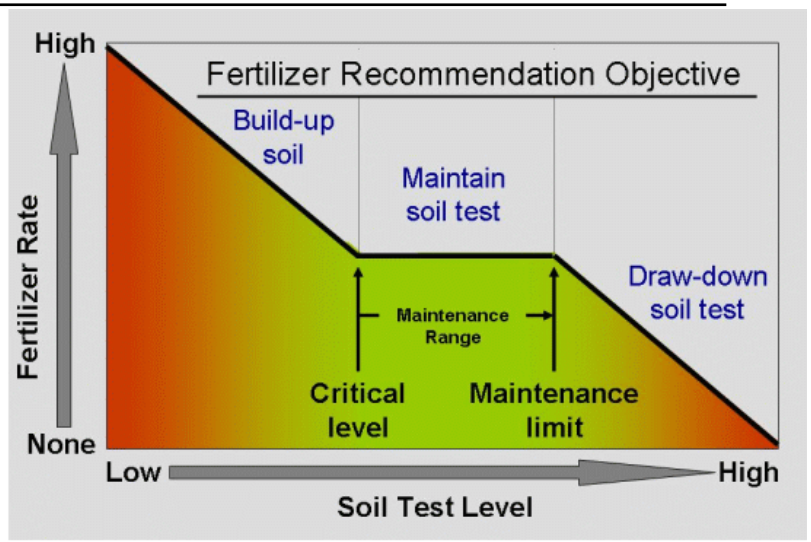
Background – Why build soil test P and K values?

Olsen soil test P category	Expected time P fertilizer will increase corn grain yield	Expected yield without P fertilizer
Very Low (1-3 ppm)	87%	87%
Low (4-7 ppm)	83%	90%
Medium (8-11 ppm)	27%	98%
High (12-15 ppm)	13%	99%
Very High (>15 ppm)	7%	99%

SOURCE: Kaiser, D. E., Fernandez, F., & Coulter, J. (2020). Fertilizing corn in Minnesota. Regents of the University of Minnesota. Available online: https://extension. umn. edu/crop-specific-needs/fertilizing-corn-Minnesota (accessed on 26 December 2024). Fertlizing corn in Minnesota.



Questions from growers about P

- Can you actually increase soil test phosphorus on high pH and calcareous soils?
  - We know high pH and calcium carbonate do increase phosphorus fixation.
- How much P does it actually take to move these soil test numbers in our upper Midwest soils?

Long-term phosphorus and potassium fertilizer rate trial

- **Site:** Northwood, ND
  - Bearden silty clay loam
  - Soil pH: 7.9
  - Carbonate: 4.5% CCE
  - Initial soil test OP: 4 ppm
  - Initial soil test K: 226 ppm
  - Initial %K: 1.1%

- **Treatments:**
  - 0 to 1,250 lb/acre MAP (11-52-0)
  - 0 to 8,500 lb/acre potash (0-0-60)
  - rototilled to 6 inches after application

Trial initiated: September 1, 2021

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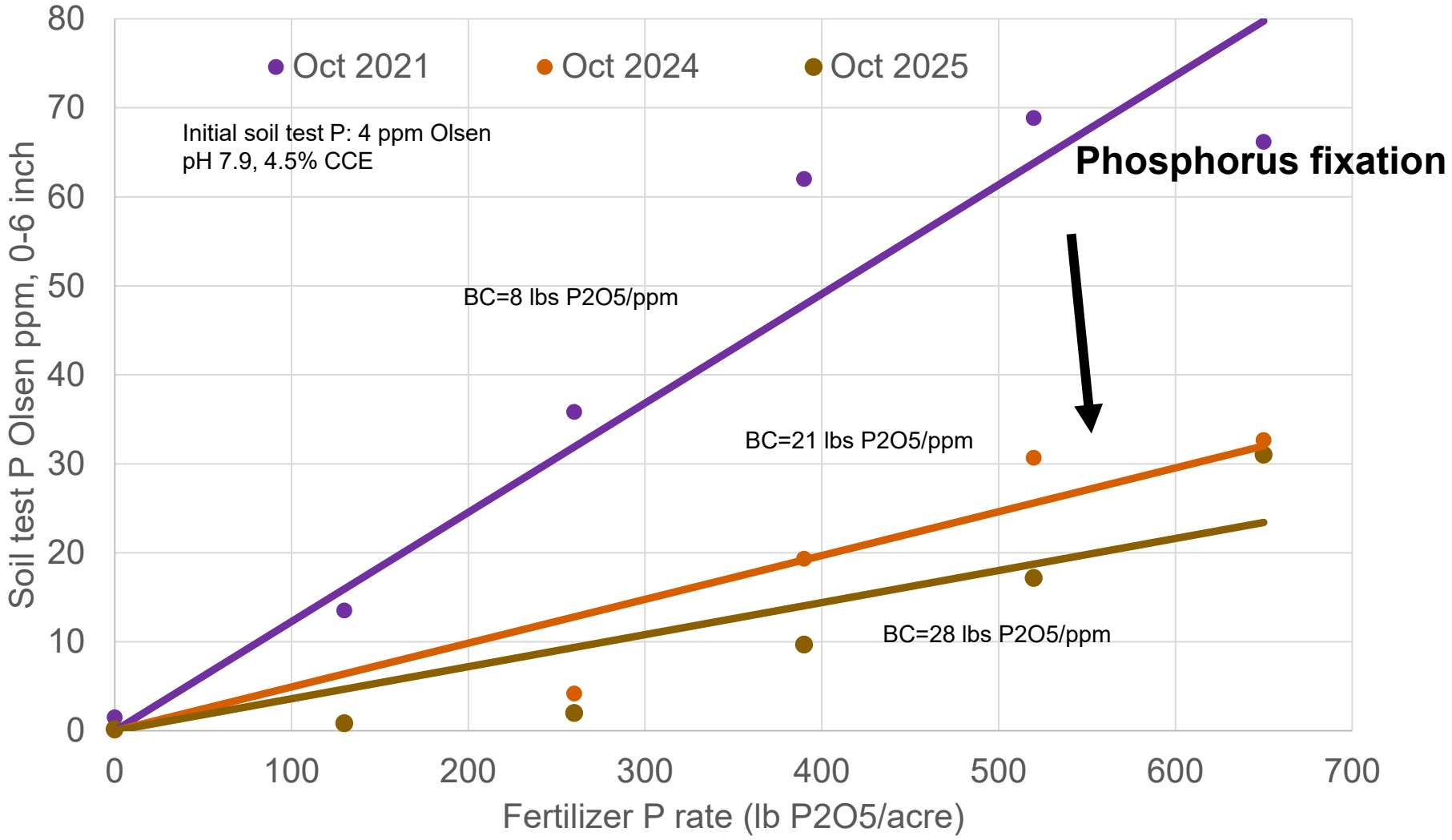

Oct 2021
Oct 2024
Oct 2025
Initial soil test P: 4 ppm Olsen
pH 7.9, 4.5% CCE
Phosphorus fixation
BC=8 lbs P2O5/ppm
BC=21 lbs P2O5/ppm
BC=28 lbs P2O5/ppm
Soil test P Olsen ppm, 0-6 inch
Fertilizer P rate (lb P2O5/acre)
0
10
20
30
40
50
60
70
80
0
100
200
300
400
500
600
700

Soil buffering capacity, so far

Soil buffering capacity (building factor) describes how much added nutrient (fertilizer) is required to increase the soil test level. Factors include soil pH, soil texture, mineralogy, carbonate, and others.

Bearden silty clay loam, pH 7.9, 4.5% CCE.

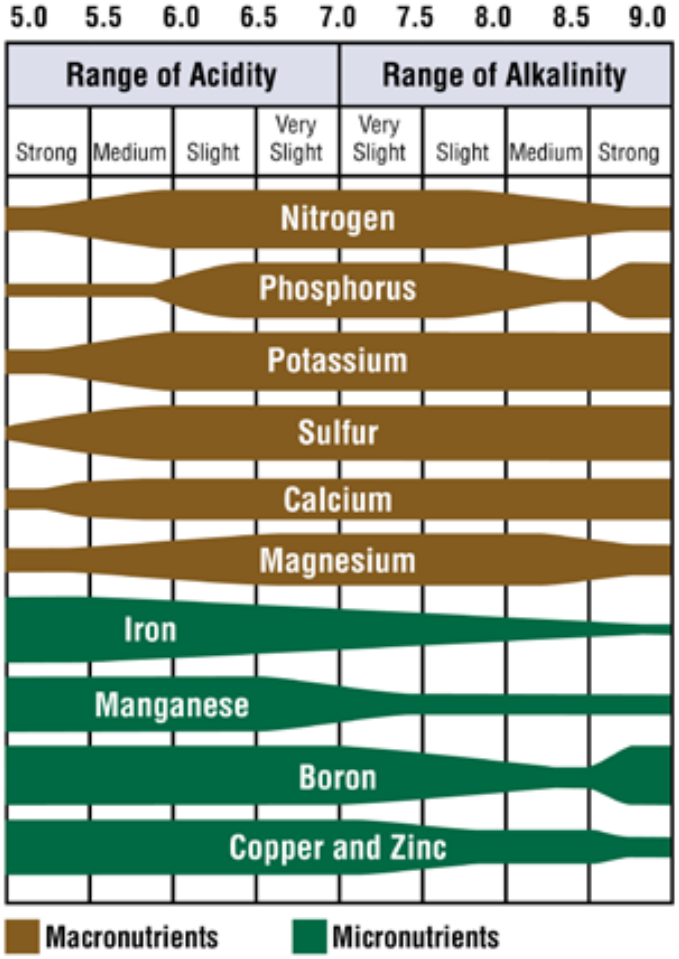
Parameter	General range	Unit	Oct. 2021 (2 months)	Oct. 2025 (50 months)
Soil test P (Olsen)	15-20 lb/ 1 ppm	P_2O_5	7.2 lb/ppm	28.0 lb/ppm

Quick observations

Phosphorus

- Soil test P increased quickly from “fresh” P
- Phosphorus fixation is occurring and decreasing soil test P

Soil pH



Purdue Extension publication ID - 179

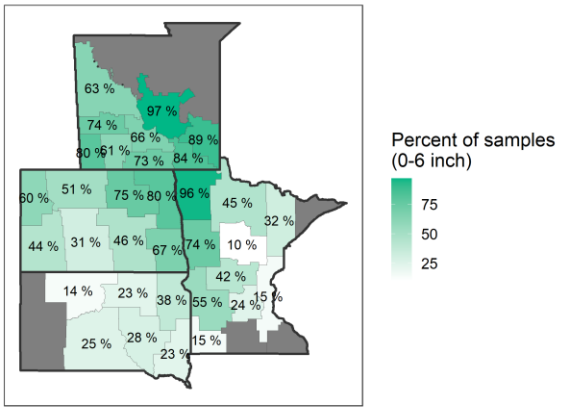
Atrazine carryover at pH > 6.8

Purdue Extension publication ID – 2018.13

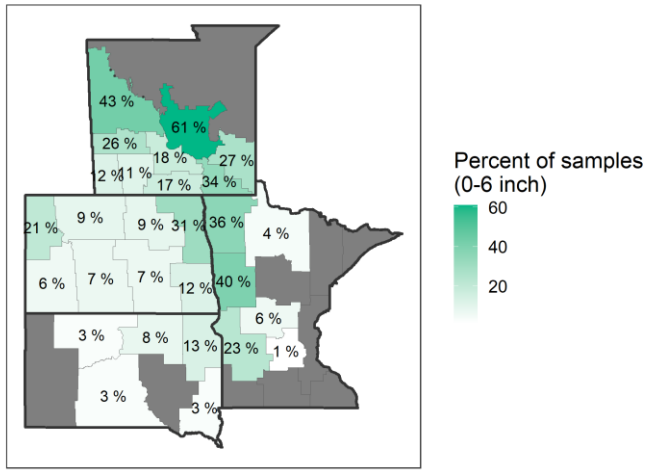
Is there an easy way to lower high pH?

- Soils in the Northern Great Plains often have soils with high pH (>7.3)
  - Soils with free calcium carbonate ($CaCO_3$) will have a pH buffered around 8
- Soil pH controls availability of plant nutrients
  - Lowering soil pH may increase nutrient availability
- Elemental sulfur often marketed as an “easy solution” to reduce pH

Soil samples with soil pH above 7.3 in 2024



Soil samples with calcium carbonate above 5.0 % CCE in 2024



Picture from: https://www.amazon.com/Walts-Elemental-Sulfur-Pellets-10/dp/B016YYNMB4

Soil Acidity Produced by N and S Fertilizers

Fertilizer Source	Soil Reaction	$CaCO_3$ Equiv.
Anhydrous ammonia	$NH_3 + 2O_2 \rightarrow H^+ + NO_3^- + H_2O$	3.6
Urea	$(NH_2)_2CO + 4O_2 \rightarrow 2NO_3^- + 2H^+ + CO_2 + H_2O$	3.6
Diammonium phosphate	$(NH_4)_2HPO_4 + O_2 \rightarrow 2NO_3^- + 3H^+ + H_2PO_4^- + H_20$	5.4
→ Elemental sulfur	$2S + 3O_2 + H_2O \rightarrow 2SO_4^{-2} + 4H^+$	7.2
Ammonium Sulfate	$(NH_4)_2SO_4 + 4O_2 \rightarrow 2NO_3^- + 4H^+ + SO_4^{-2} + H_2O$	7.2

CaCO3 equivalent: lbs. CaCO3 required per lbs. N applied to neutralize acidity in the fertilizer

SOURCE: Adams, 1984, Soil Acidity and Liming, No. 12, p. 234 ASA

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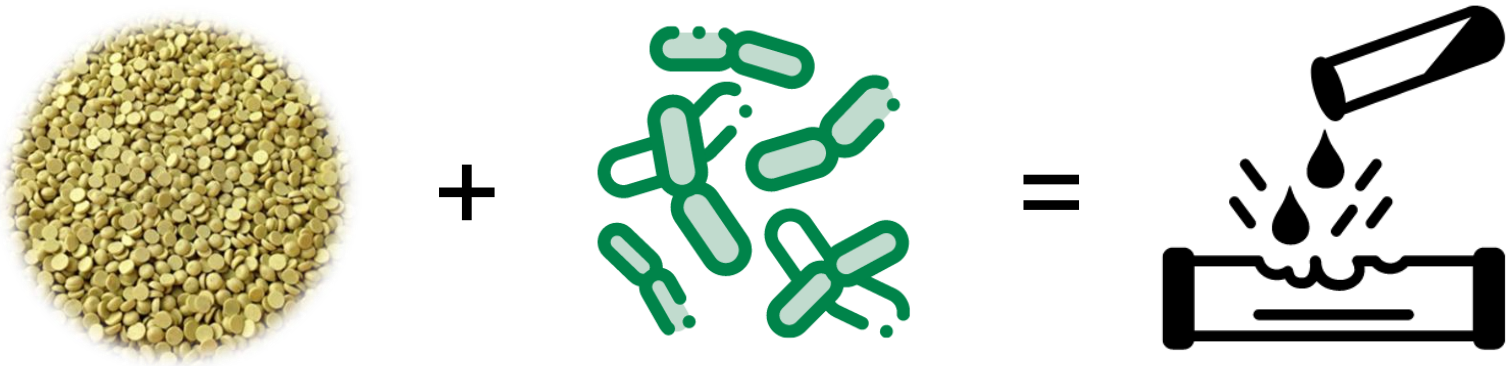
The science behind lowering pH with elemental sulfur

- High pH soils have “free lime” ($CaCO_3$)
- Free lime must be neutralized before pH can be reduced
- When S^0 is applied to soil, it is oxidized by soil bacteria (*Thiobacillus*). Thus, forming sulfuric acid



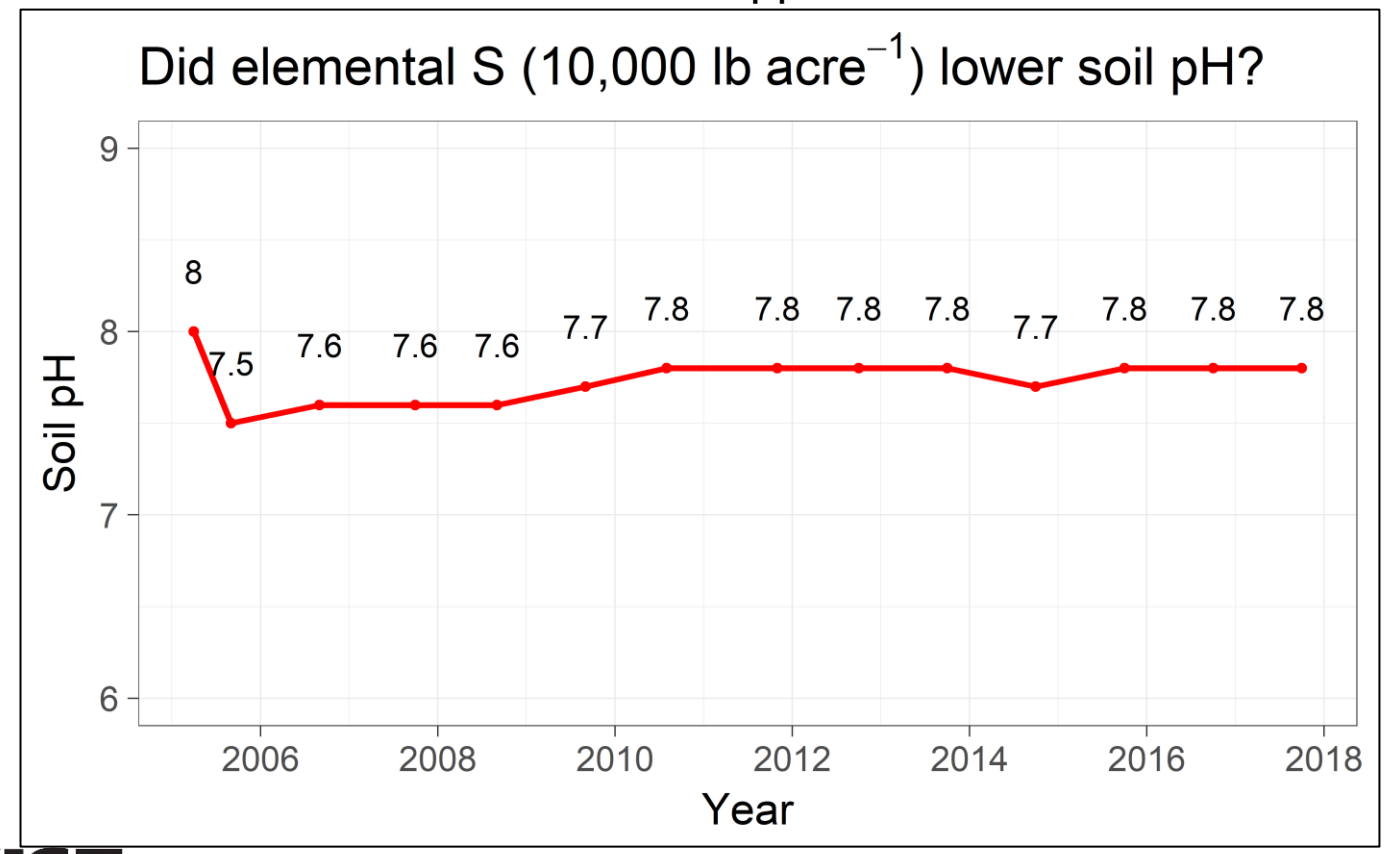
- Sulfuric acid produces H^+ ions, which can neutralize free lime in the soil
- Any other form of sulfur fertilizer (e.g. gypsum) is in the sulfate form of sulfur and CAN NOT neutralize free lime

I only need about 100 lb/A elemental sulfur, right?

AGVISE Demonstration 2005-2017

Soil had 1.5% CCE, starting pH was 8

Elemental S applied in 2005

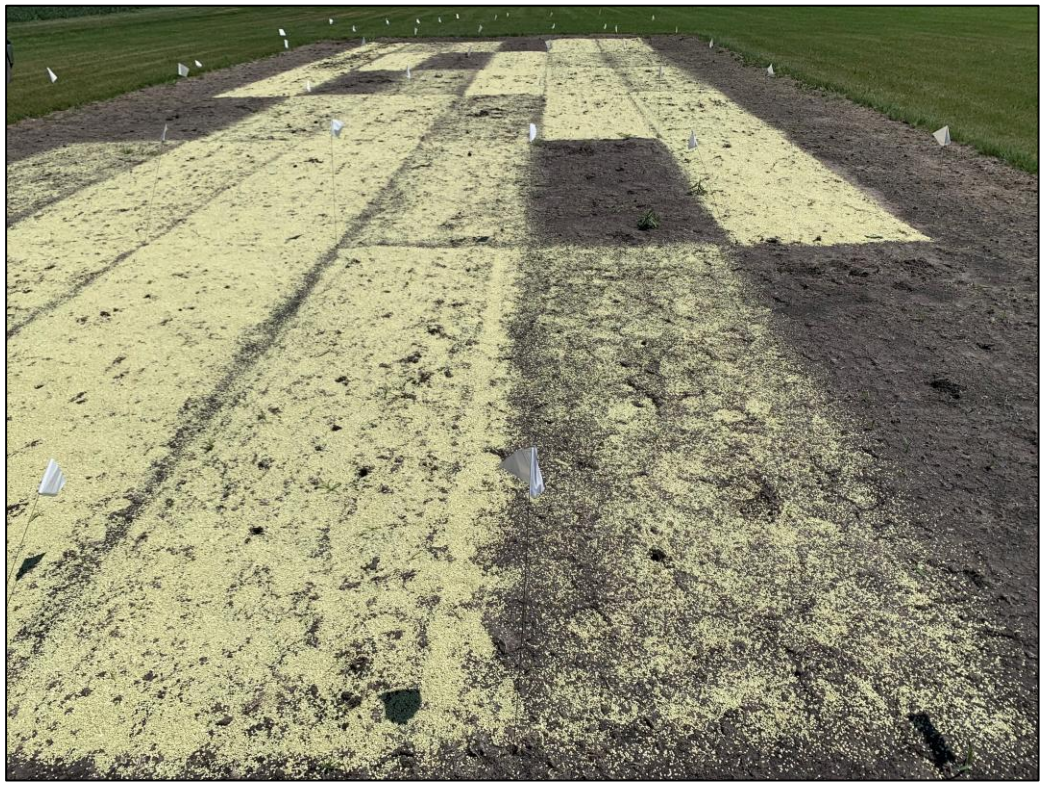


Again starting in 2020, with higher rates!

Objective: evaluate long-term effectiveness of elemental S as a soil amendment to reduce soil pH on a calcareous Northern Plains soil.

Site: Northwood, ND
Bearden silty clay loam, soil pH 8.0,
average **CCE: 4.5%**

Treatments: 0 to 40,000 lbs/A elemental sulfur, tilled to 6” after application



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

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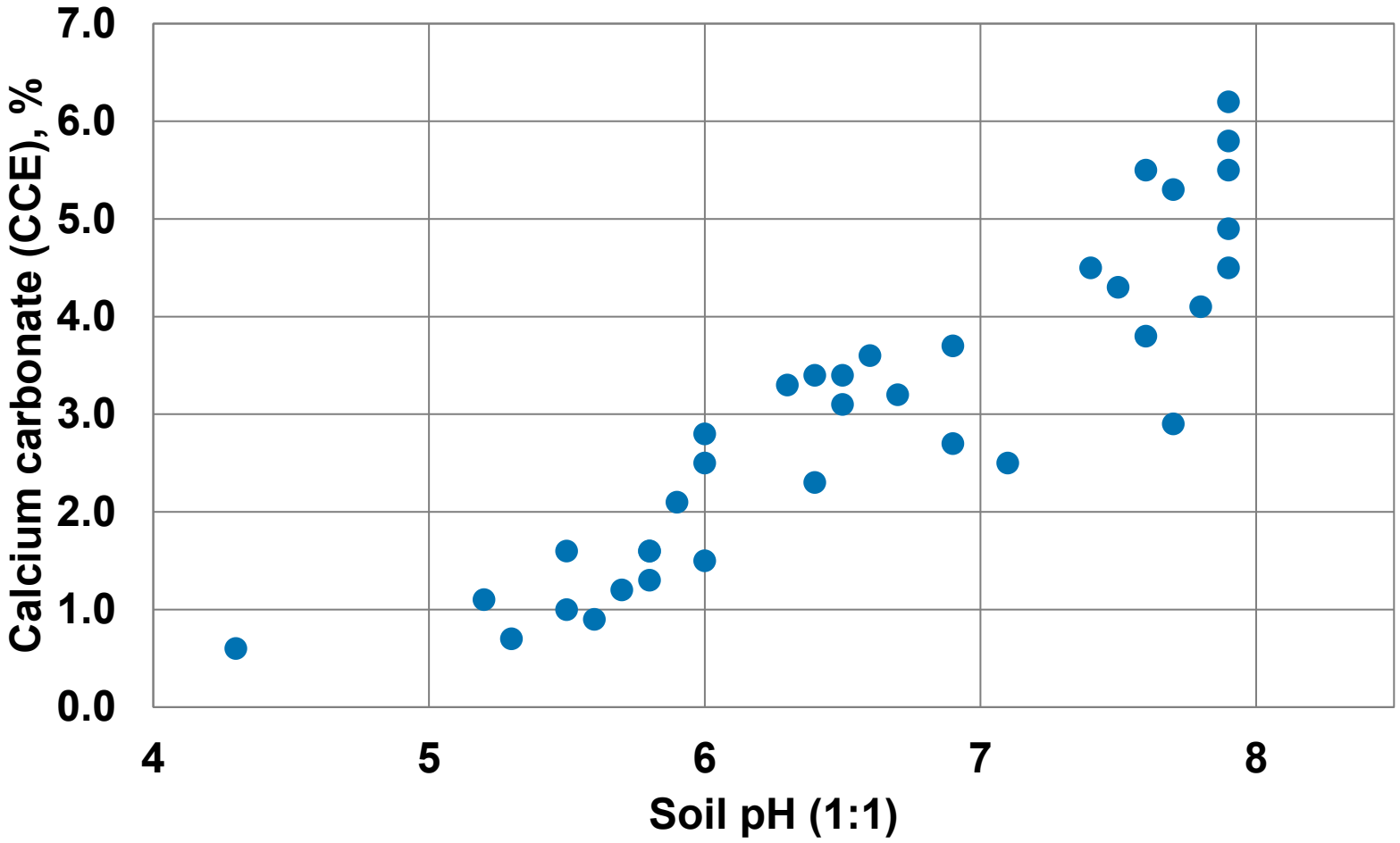
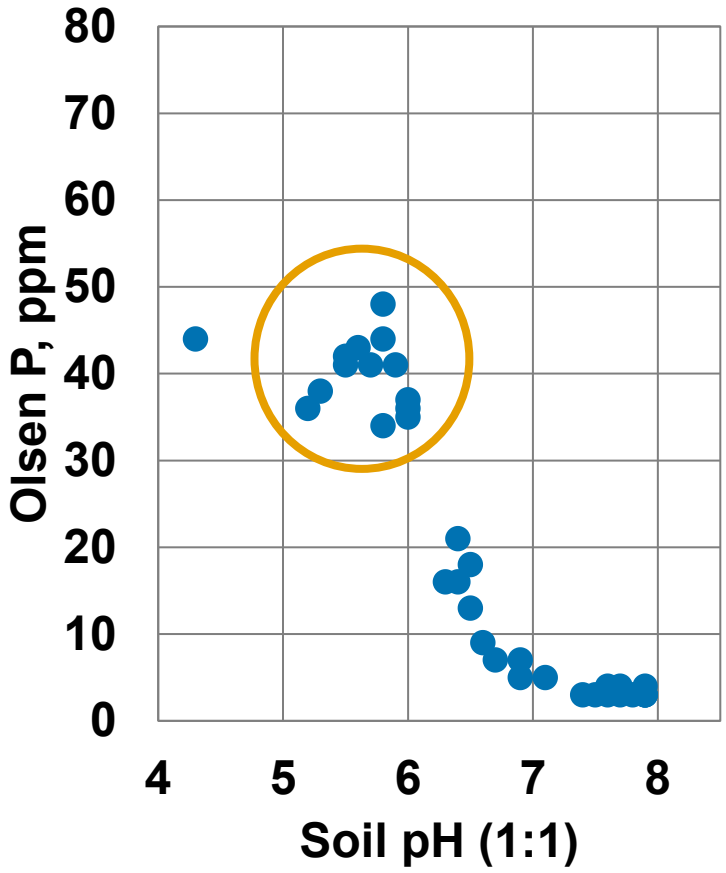
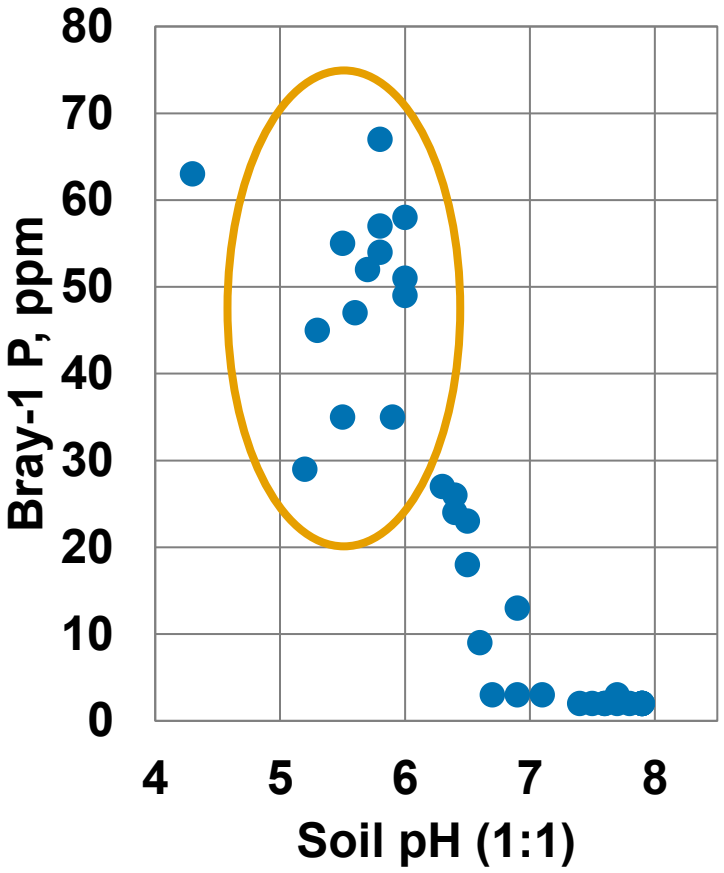
Comparing soil test parameters
October 2025



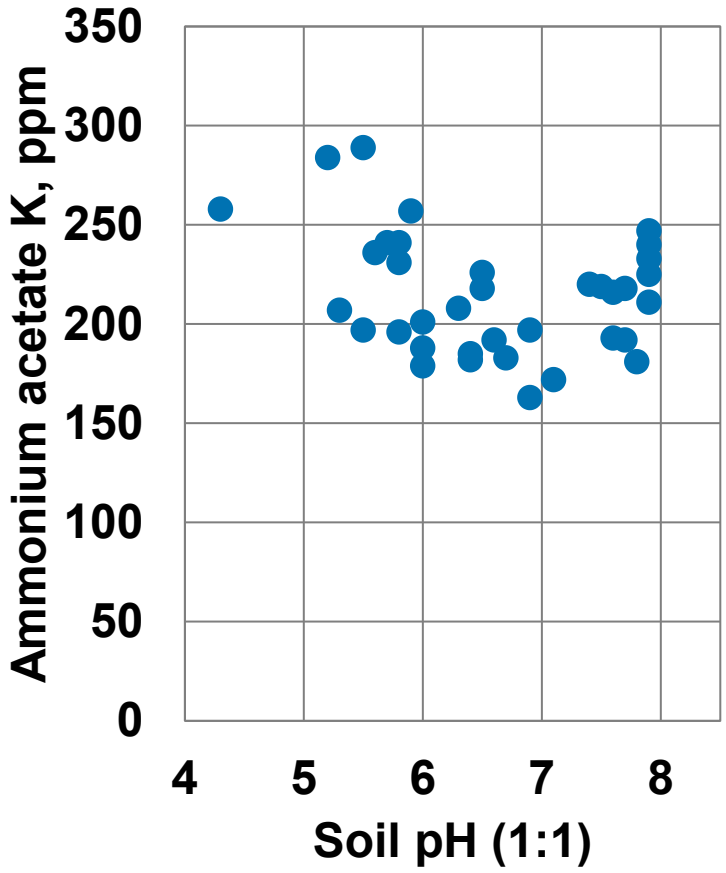
Comparing soil test parameters October 2025

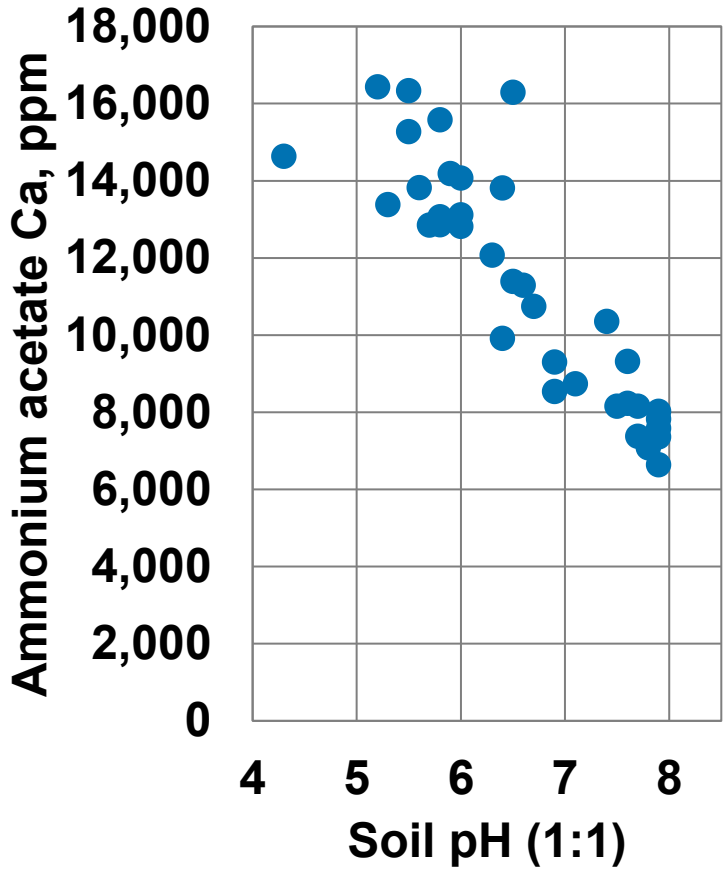




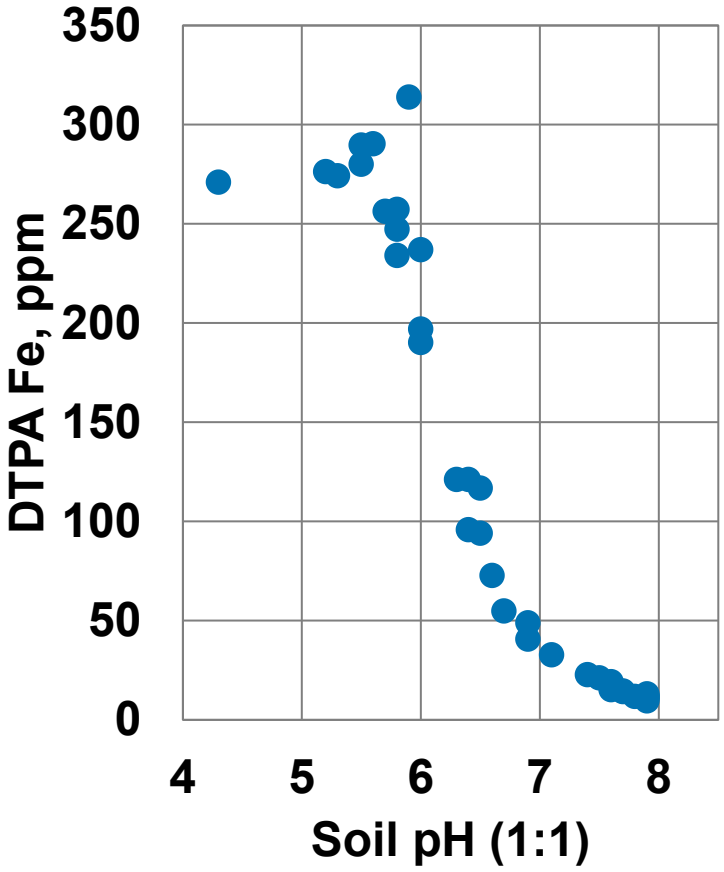
Background Olsen P 4 ppm; Bray-1 P failed at pH < 6.5

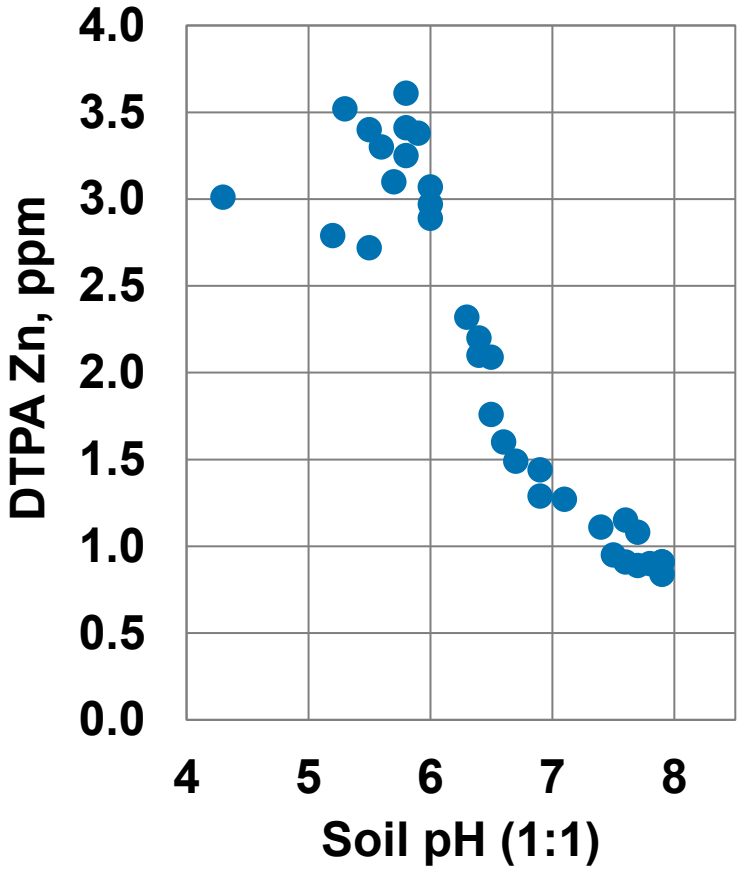
Comparing soil test parameters October 2025

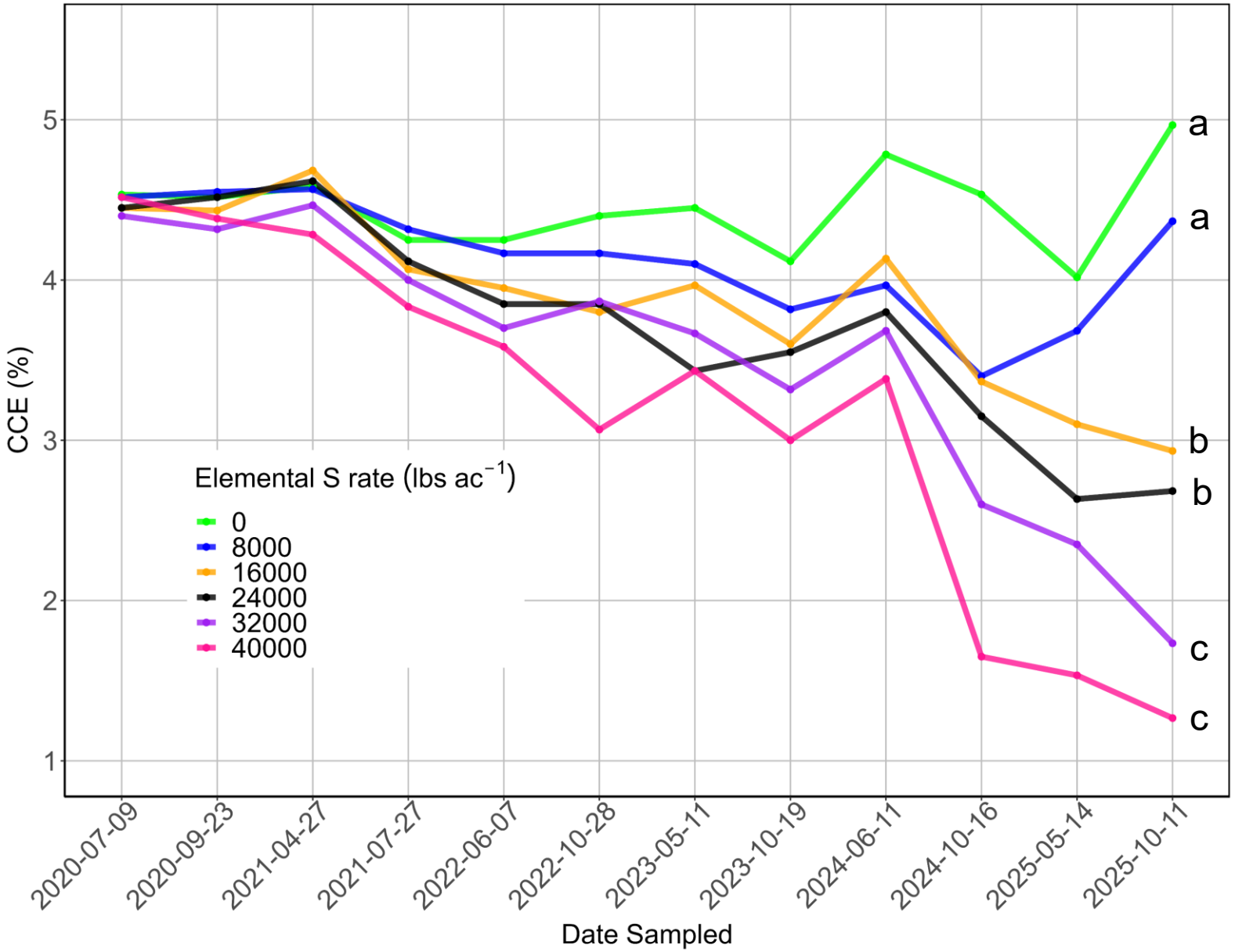


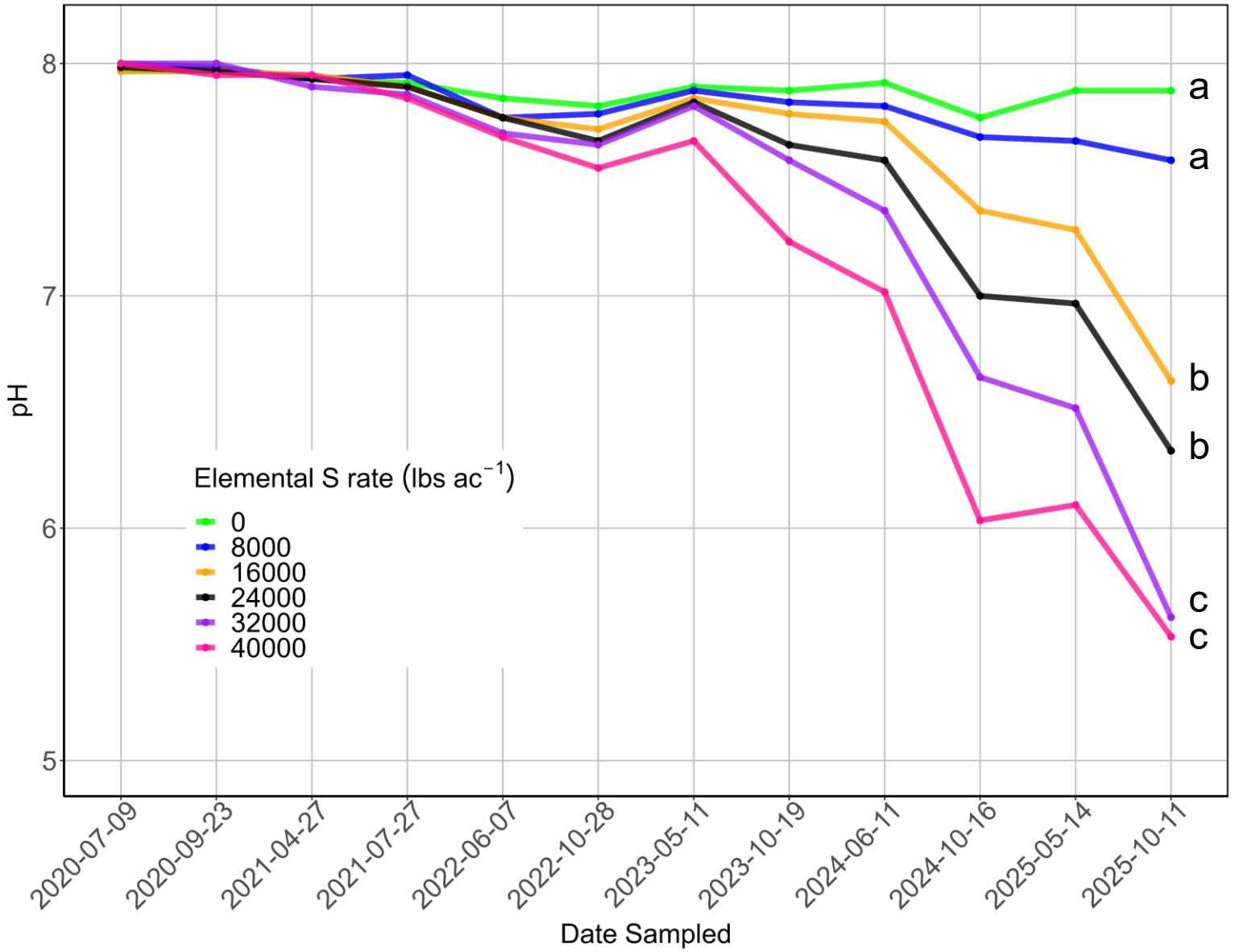


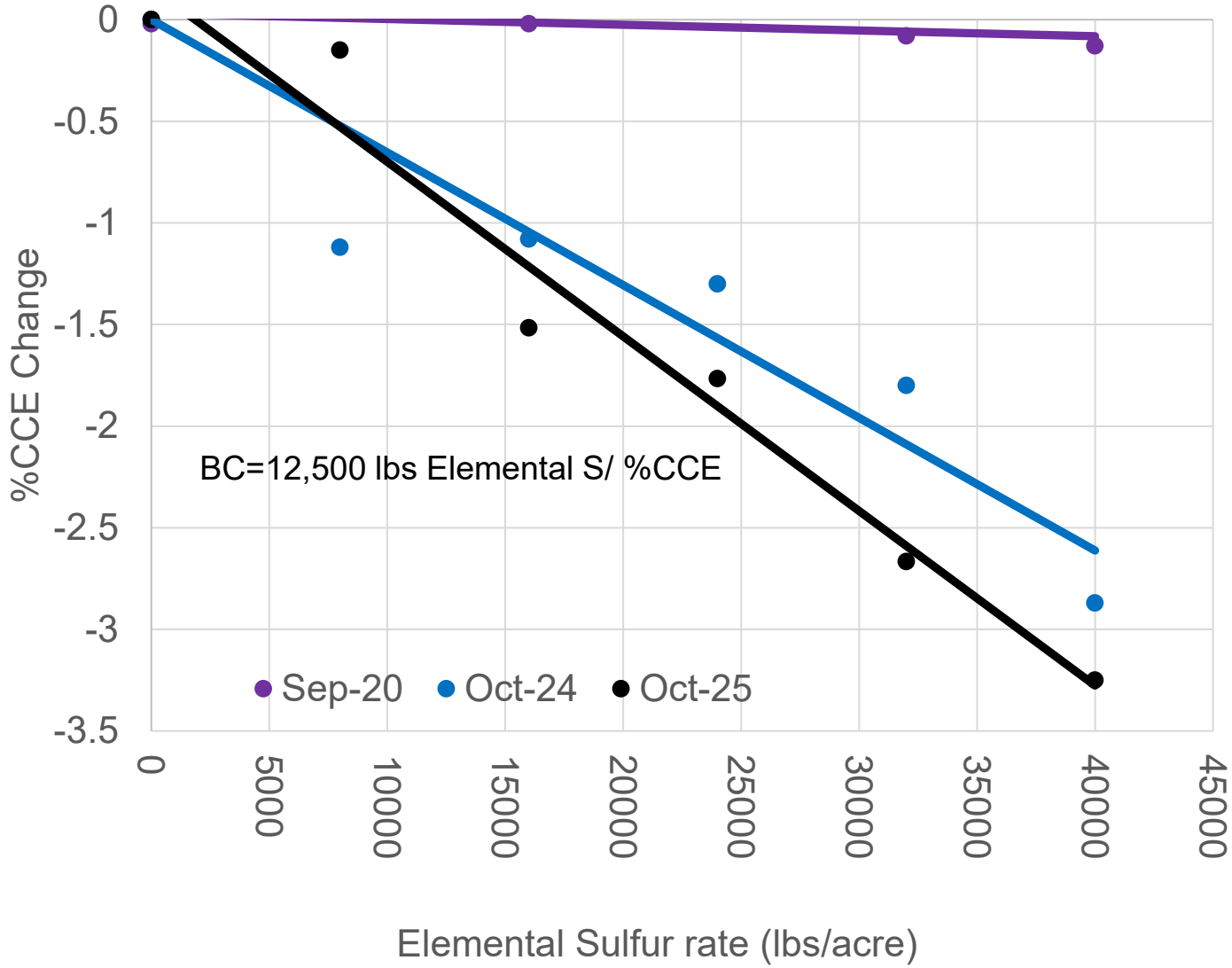
Comparing soil test parameters October 2025

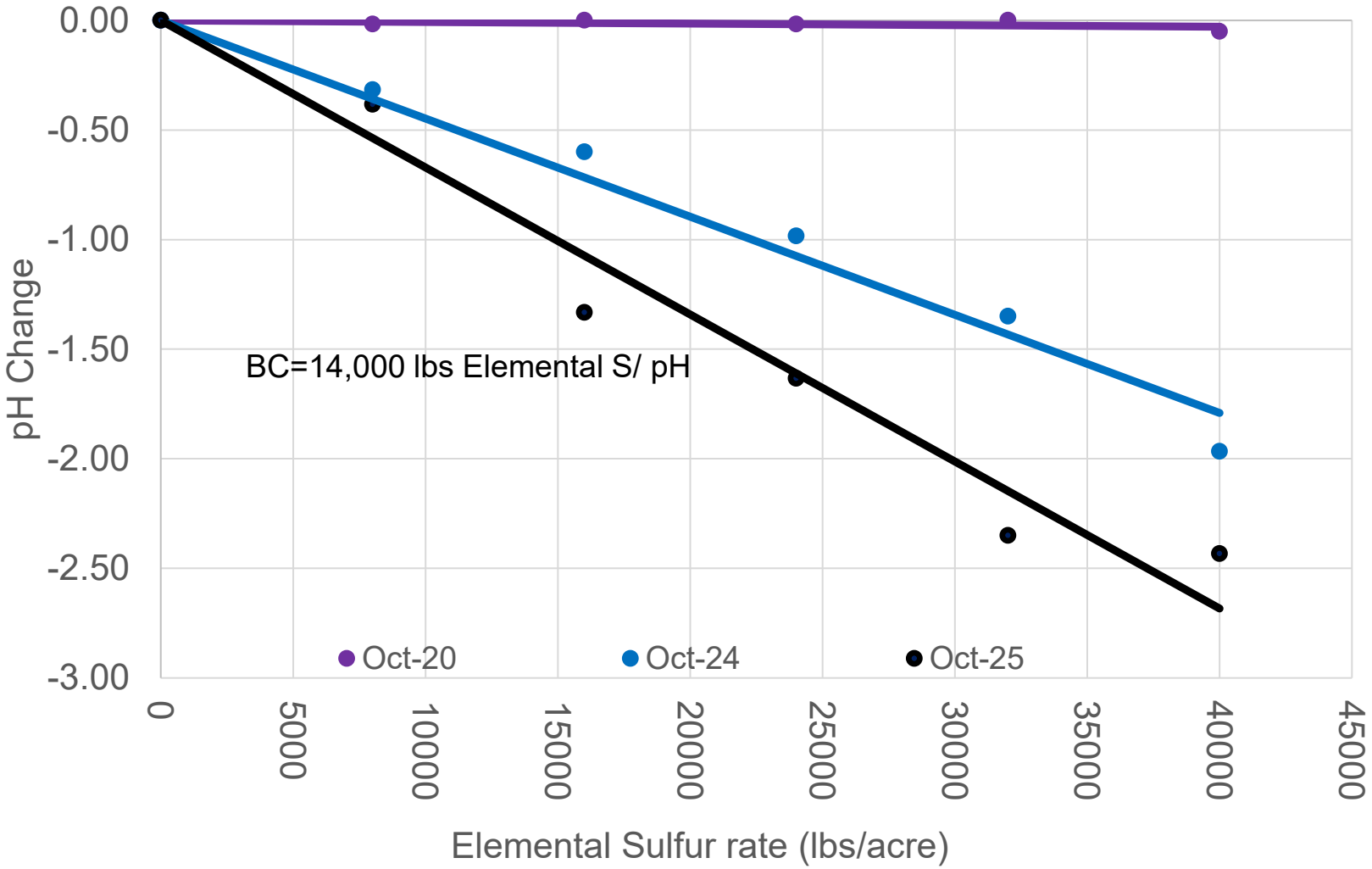





CCE (%)
5
4
3
2
1
Elemental S rate (lbs ac^{-1})
0
8000
16000
24000
32000
40000
a
a
b
b
c
c
2020-07-09
2020-09-23
2021-04-27
2021-07-27
2022-06-07
2022-10-28
2023-05-11
2023-10-19
2024-06-11
2024-10-16
2025-05-14
2025-10-11
Date Sampled


8
7
6
5
pH
Elemental S rate (lbs ac^{-1})
0
8000
16000
24000
32000
40000
a
a
b
b
c
c
2020-07-09
2020-09-23
2021-04-27
2021-07-27
2022-06-07
2022-10-28
2023-05-11
2023-10-19
2024-06-11
2024-10-16
2025-05-14
2025-10-11
Date Sampled


0
-0.5
-1
-1.5
-2
-2.5
-3
-3.5
%CCE Change
BC=12,500 lbs Elemental S/ %CCE
Sep-20
Oct-24
Oct-25
0
5000
10000
15000
20000
25000
30000
35000
40000
45000
Elemental Sulfur rate (lbs/acre)


0.00
-0.50
-1.00
-1.50
-2.00
-2.50
-3.00
pH Change
BC=14,000 lbs Elemental S/ pH
Oct-20
Oct-24
Oct-25
0
5000
10000
15000
20000
25000
30000
35000
40000
45000
Elemental Sulfur rate (lbs/acre)

Conclusion

- The process that turns elemental sulfur into sulfuric acid is biology driven.
  - Dry conditions: 2020 – 2021, 2023
  - Wet conditions: 2022 and 2024

There is no quick, easy solution to reducing soil pH in the northern Great Plains/Prairie Provinces

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SCN

Introduction-SCN

- Annual losses of $1.5 billion
- Main source of resistance is PI 88788
  - 95% contain this resistance
- Capacity to survive long term without soybeans
- First reported
  - MN-1978
  - SD- 1995
  - ND-2003
  - Manitoba-2019

Courtesy: Mike Janssen

IOWA STATE UNIVERSITY
Extension and Outreach

Integrated Crop Management

Greg Tylka *Professor*

Dr. Greg Tylka is a professor in the Department of Plant Pathology and Microbiology at Iowa State University with extension and research responsibilities for management of plant-parasitic nematodes. The focus of Dr. Tylka's research program at Iowa State University is primarily the soybean cyst n...

Income in SCN-infested Fields Can Be $200 Per Acre Less With PI 88788 Than With Peking Resistance

January 9, 2020

The results of a field experiment conducted in 2019 with the soybean cyst nematode (SCN) in southeast Iowa were dramatic and alarming. The data illustrate what likely could occur in SCN-infested fields throughout the state in future years.

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https://crops.extension.iastate.edu/cropnews/2020/01/income-scn-infested-fields-can-be-200-acre-less-pi-88788-peking-resistance

Soybean varieties in Iowa

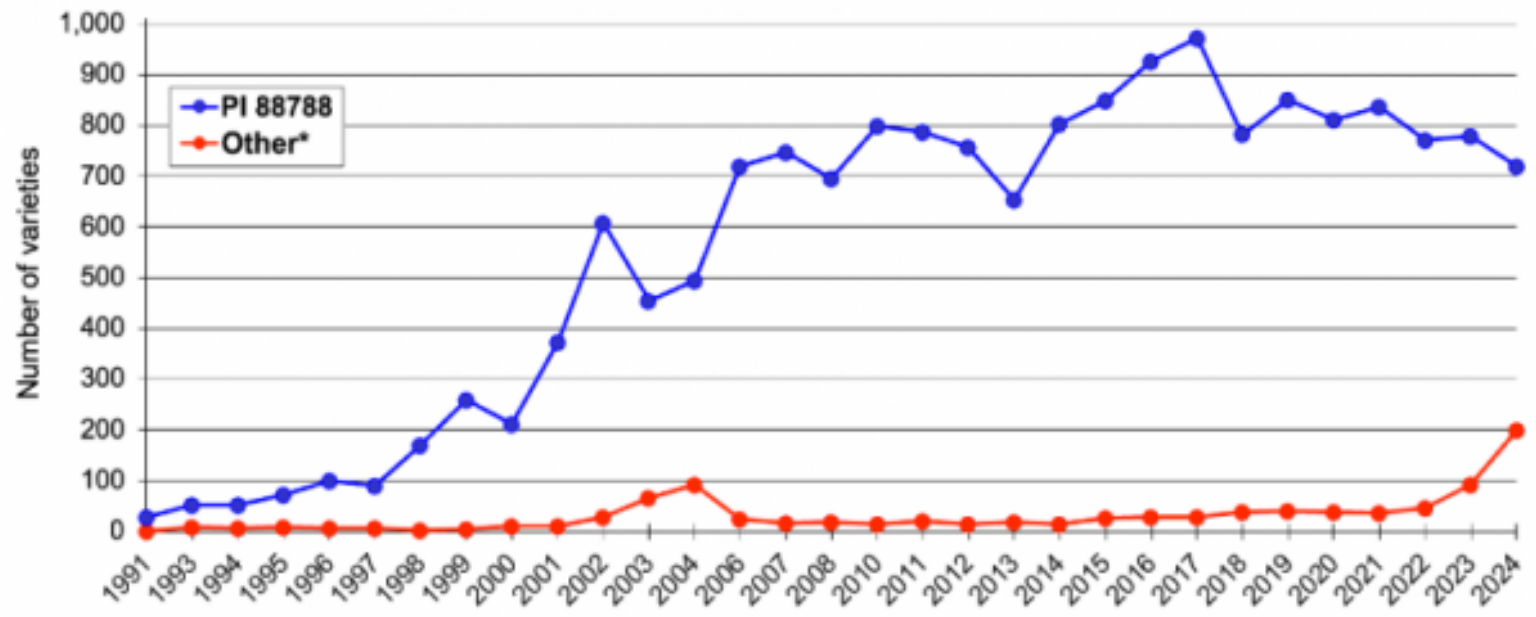
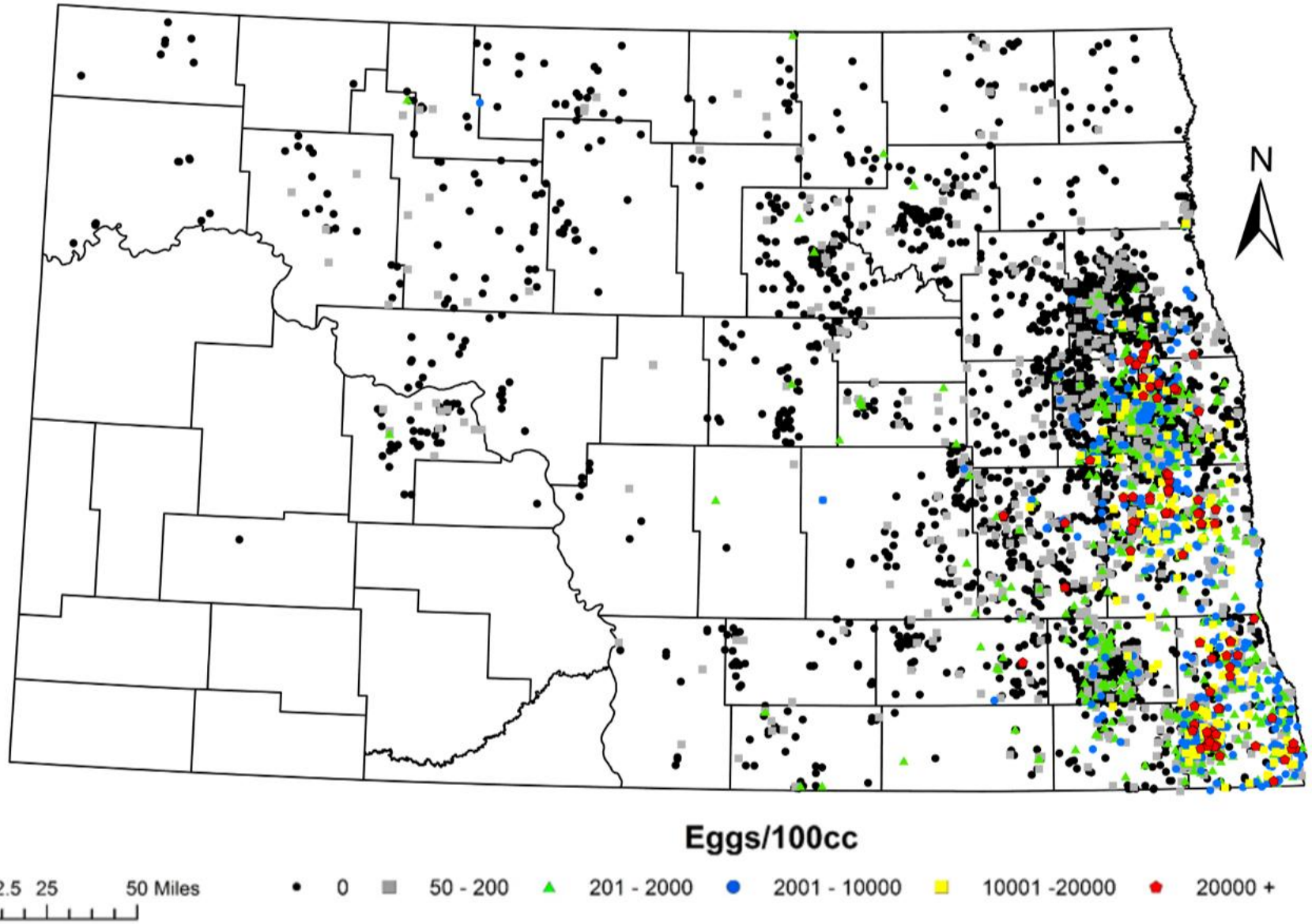


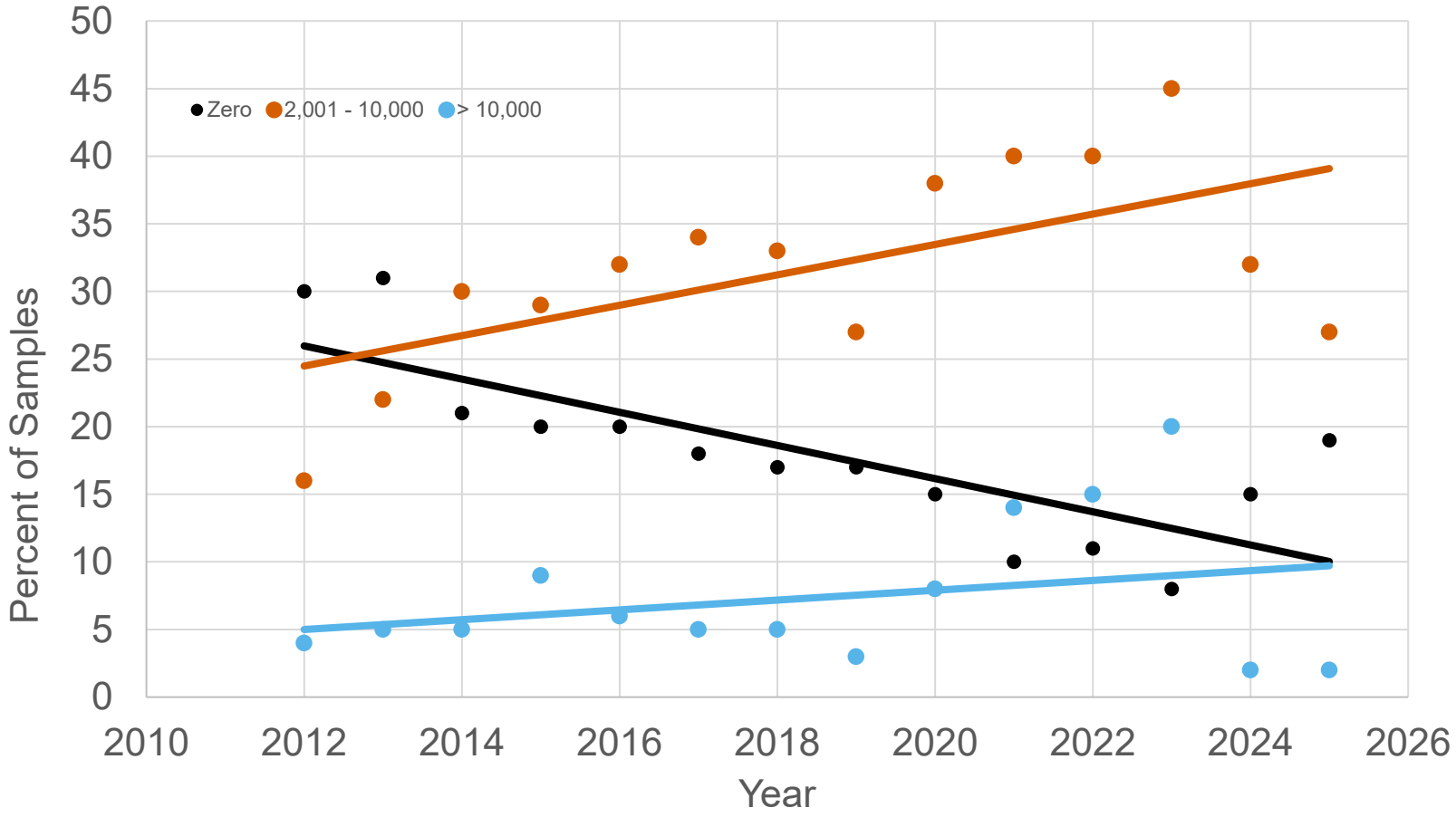
Figure 2. Number of SCN-resistant soybean varieties available for Iowa, by resistance genetics 1991 to 2024.

SCN Survey 2013-2023

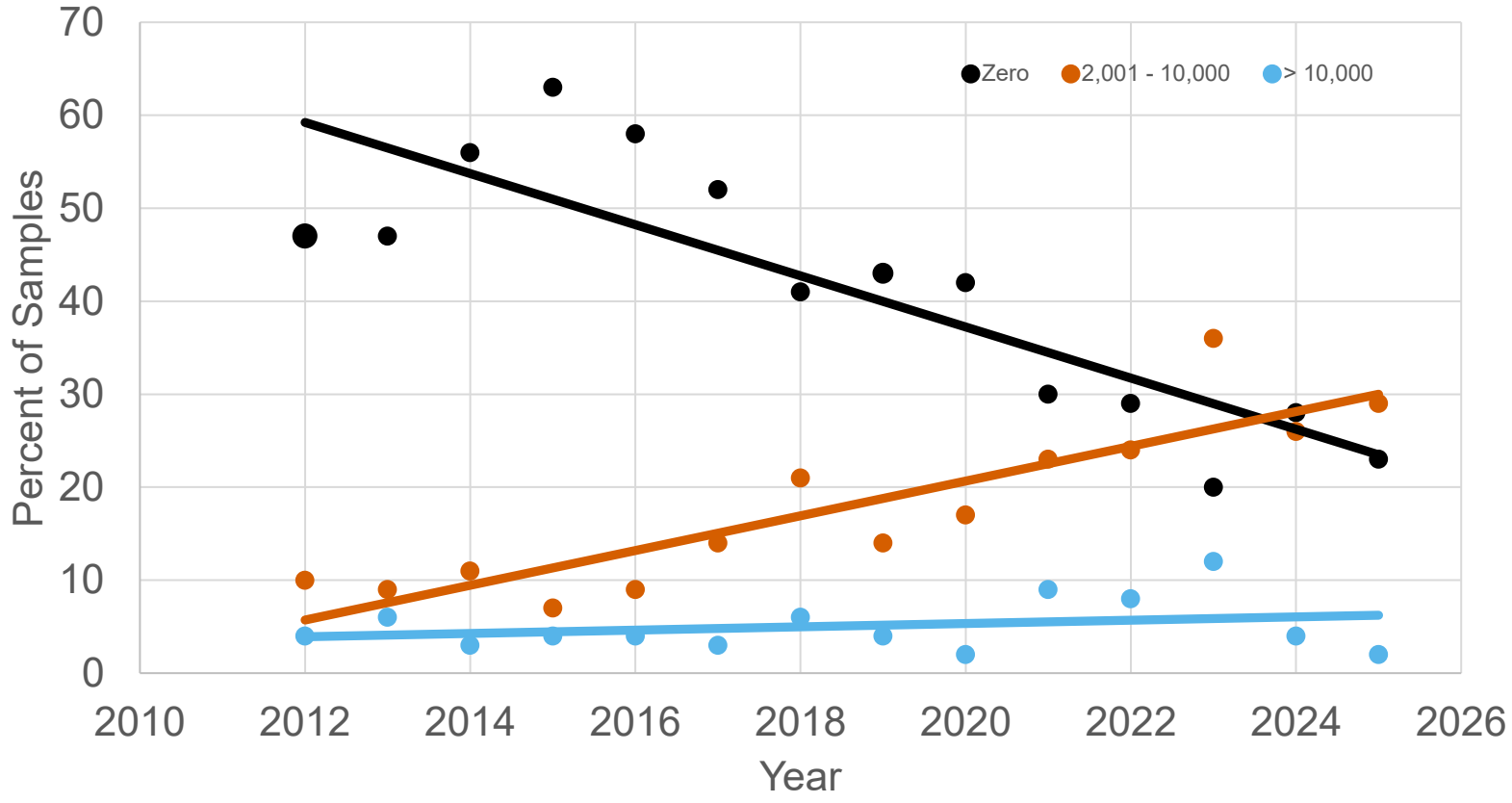


Chowdhury, I.A., G. Yan, J. Halvorson, A. Thapa, M. Halvorson, and S. Markell. 2023. Soybean cyst nematode (SCN). NDSU Ext. Circ. PP1732. North Dakota State Univ., Fargo, ND.

Minnesota SCN Egg Counts



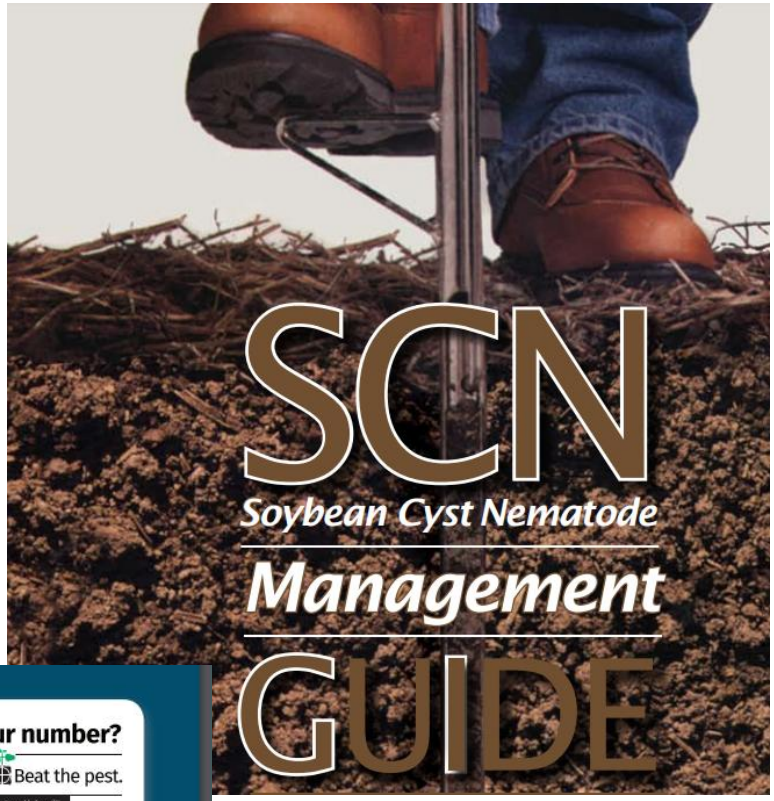
North Dakota SCN Egg Counts

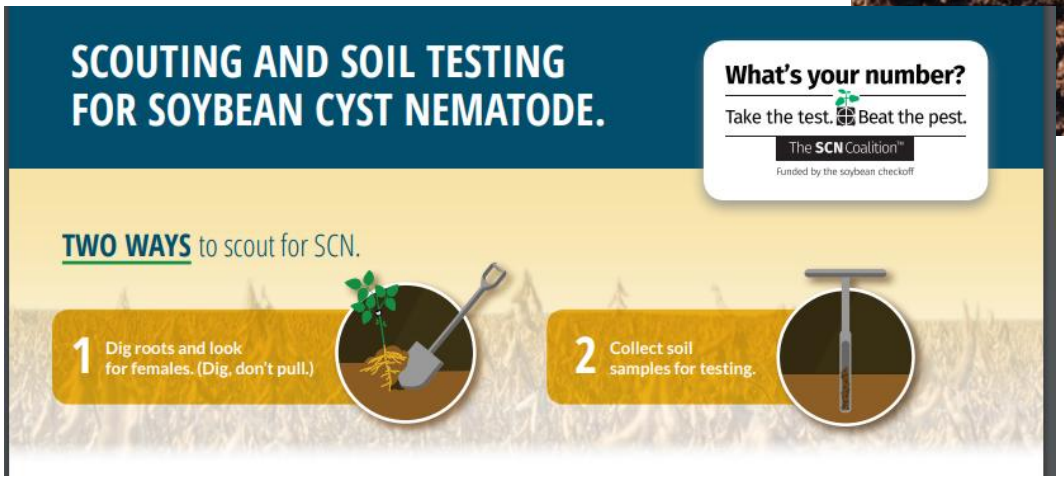


Summary

- SCN reproduction
  - Dry and hot years: increases
  - Wet years: decreases
- Why – don’t really know
- SCN eggs still need to be measured and managed

Going Forward: Start/Continue Sampling for SCN





Questions

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