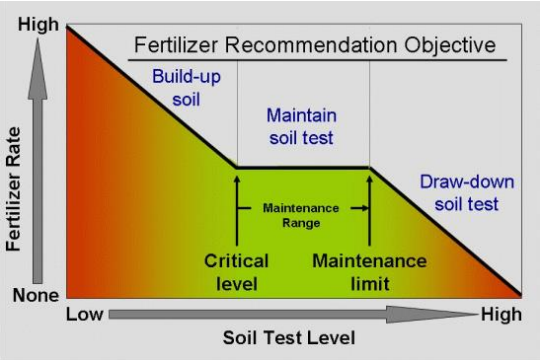
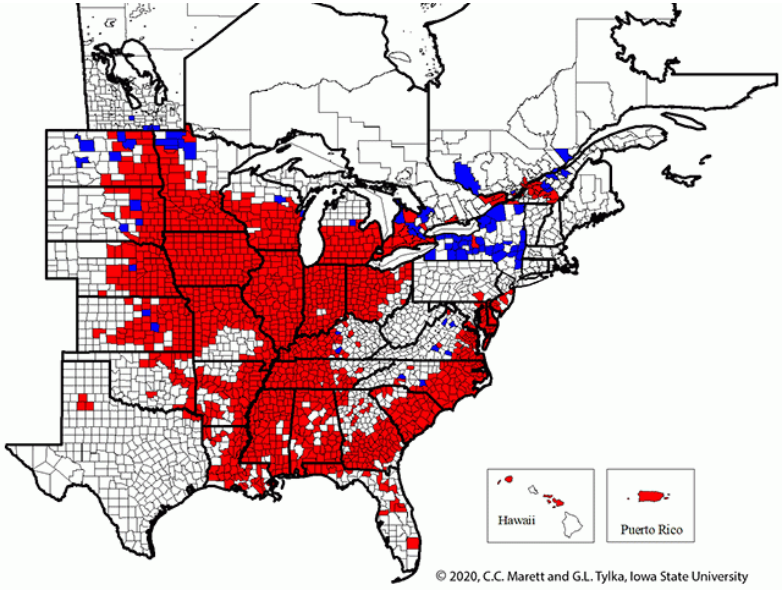
AGVISE Demonstration Project Update



Vitosh et al. (1995)



- Agvise Seminars
- January 9-11, 2024
- Brent Jaenisch, Ph.D.

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Outline

- Increasing soil test P and K values
- Decreasing soil pH with elemental sulfur
- Plant tissue sampling: Time of day
- Dry bean SCN project
- Summary

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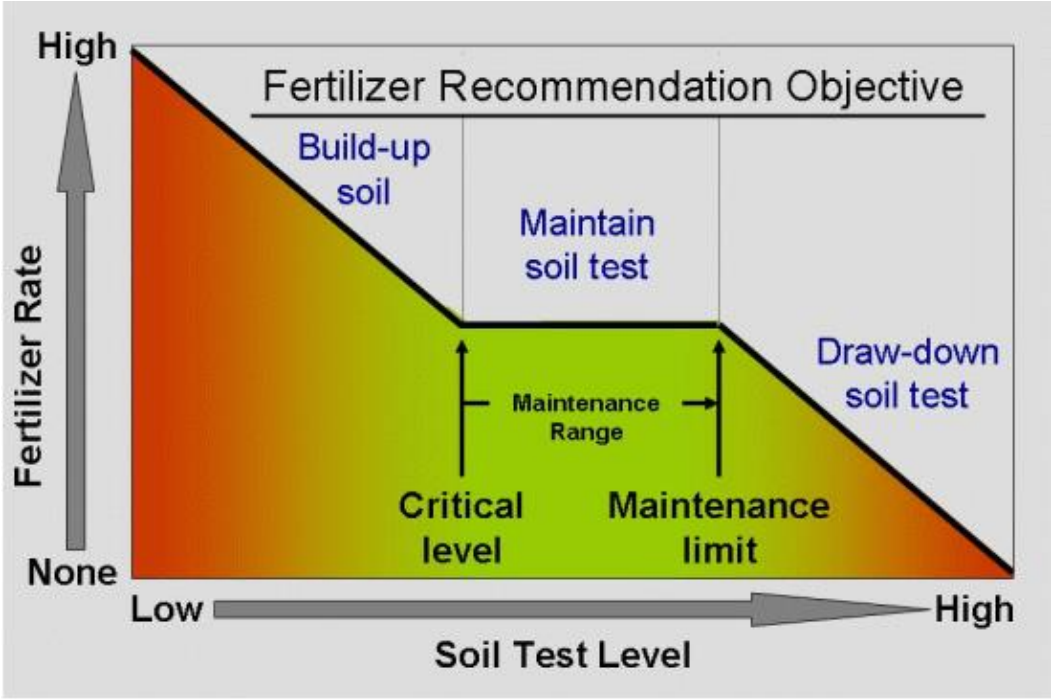
Background – Why build soil test P and K values?

- Reduce fertilizer rates when prices are high
- Risk management



Vitosh et al. (1995)

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?

Questions from growers about K

- Are you able to increase potassium saturation (%K) or base cation saturation ratios?
  - We know soils with high clay content have higher K buffering capacity.
  - We know soils with high pH, calcium carbonate, or salinity have inflated CECs and screwy BS calculations.
  - We know %K saturation is not important for soil potassium availability or crop uptake, so why do we still keep getting these questions?
- How much K does it actually take to move these soil test numbers in our upper Midwest soils?

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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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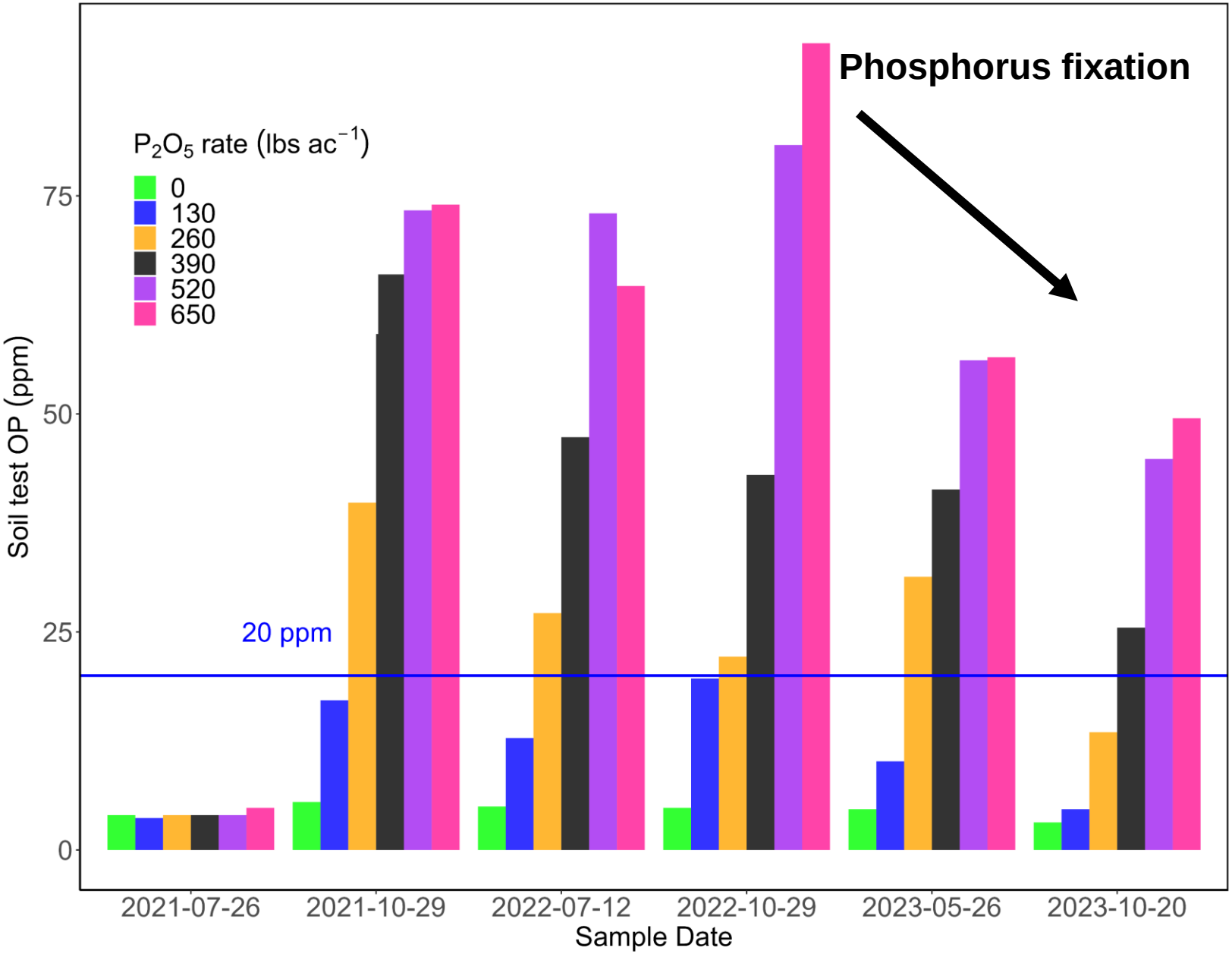
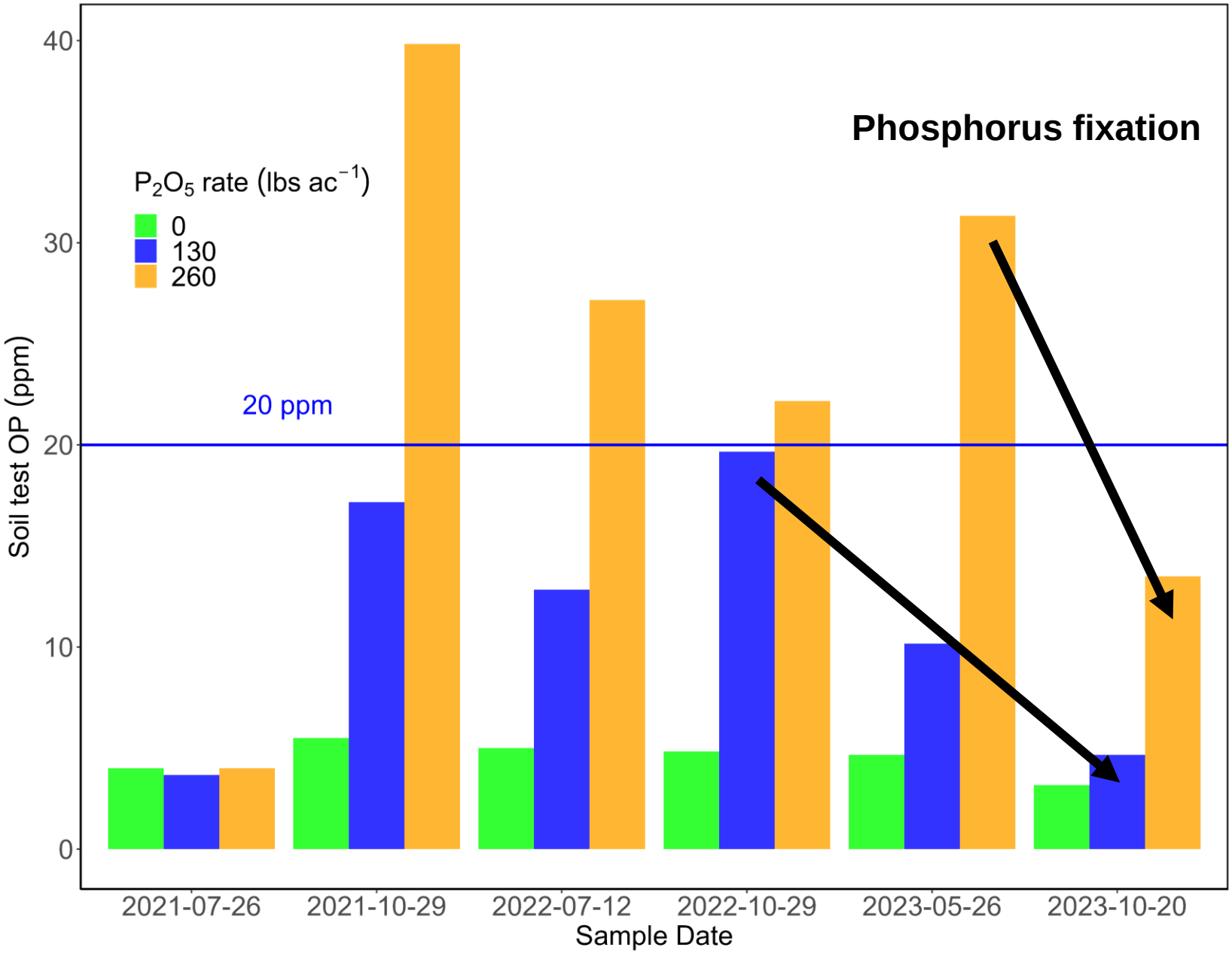
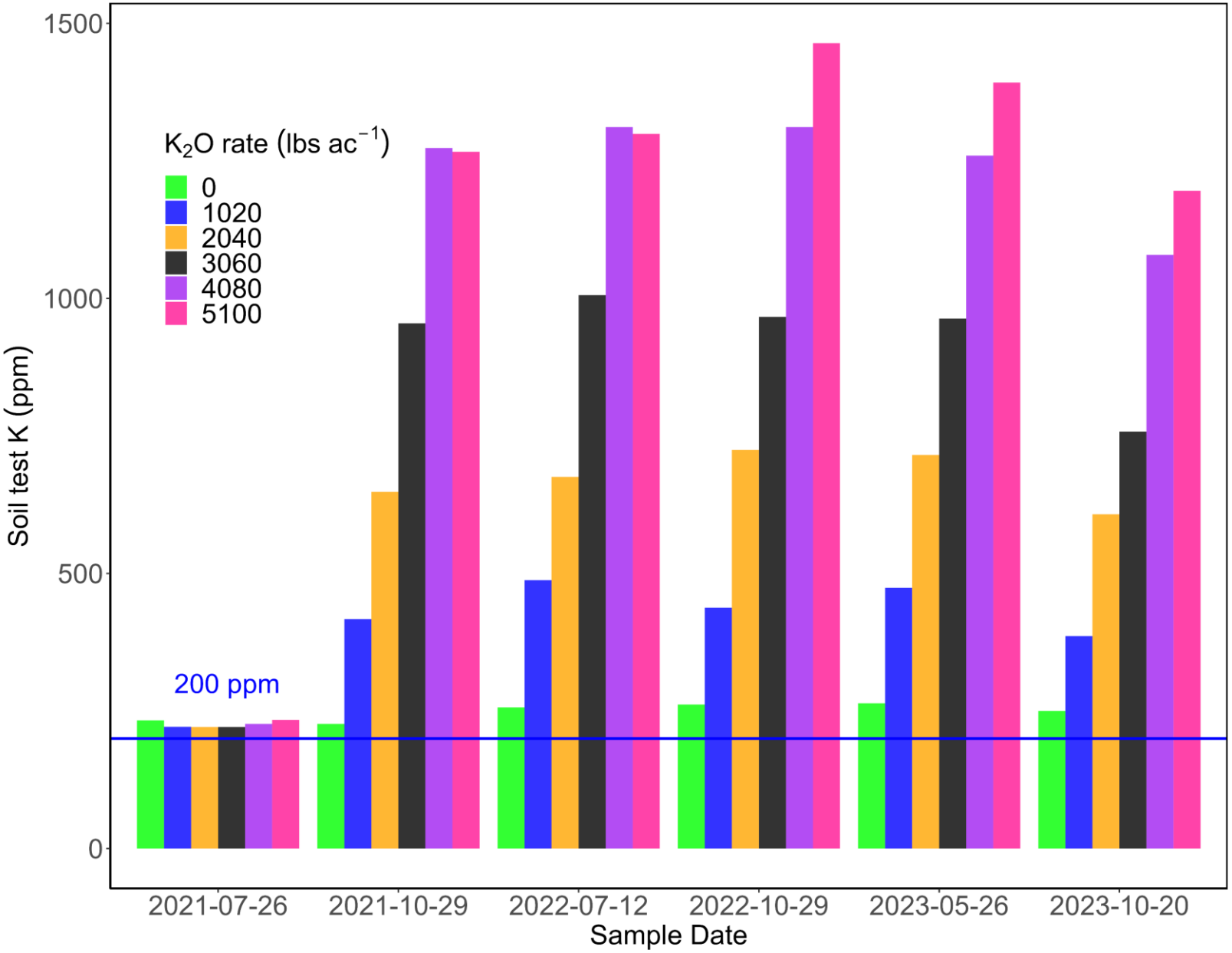

Phosphorus fixation
P_2O_5 rate (lbs ac^{-1})
0
130
260
390
520
650
Soil test OP (ppm)
75
50
25
0
20 ppm
2021-07-26
2021-10-29
2022-07-12
2022-10-29
2023-05-26
2023-10-20
Sample Date


Phosphorus fixation
P_2O_5 rate (lbs ac^{-1})
0
130
260
20 ppm
Soil test OP (ppm)
40
30
20
10
0
2021-07-26
2021-10-29
2022-07-12
2022-10-29
2023-05-26
2023-10-20
Sample Date



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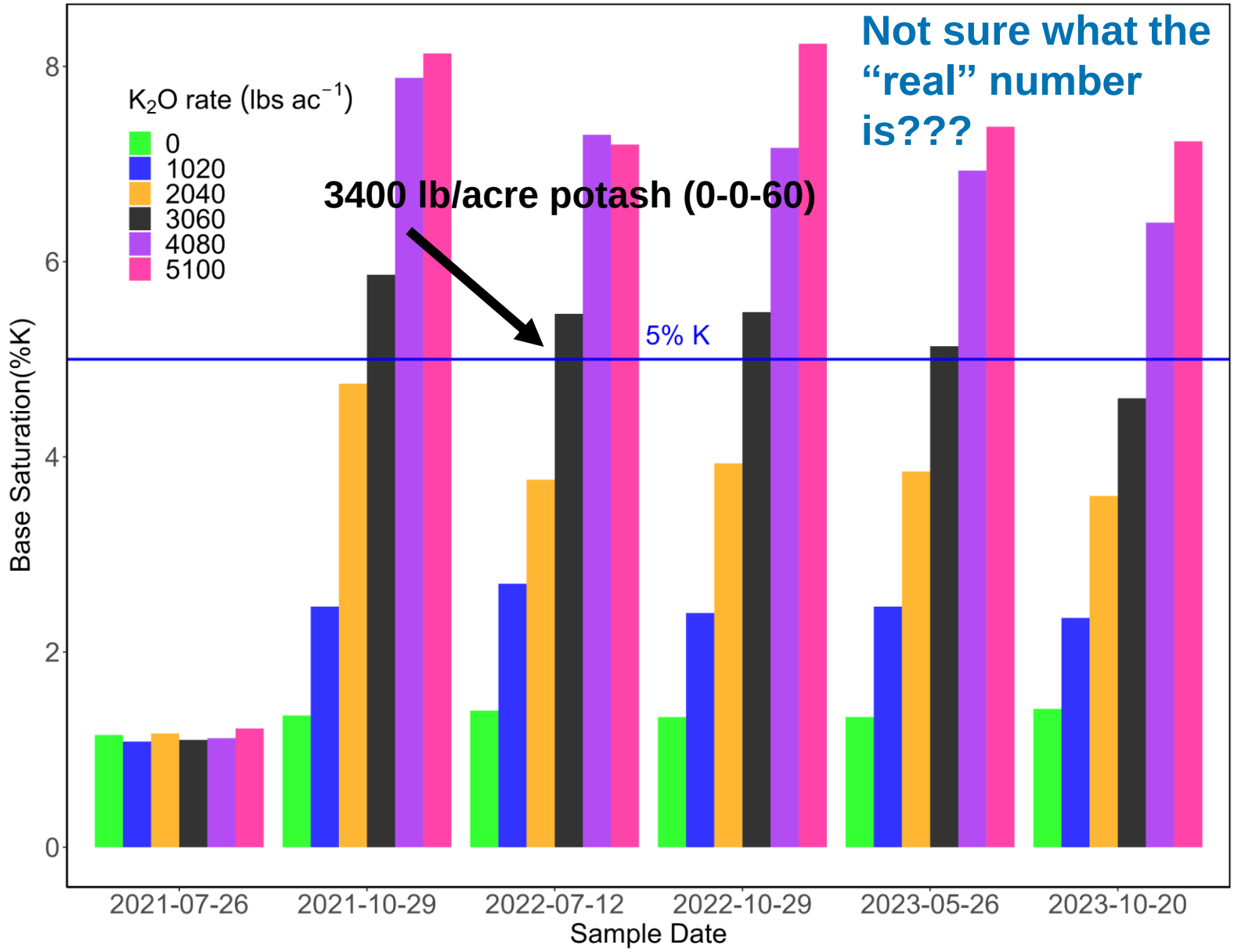
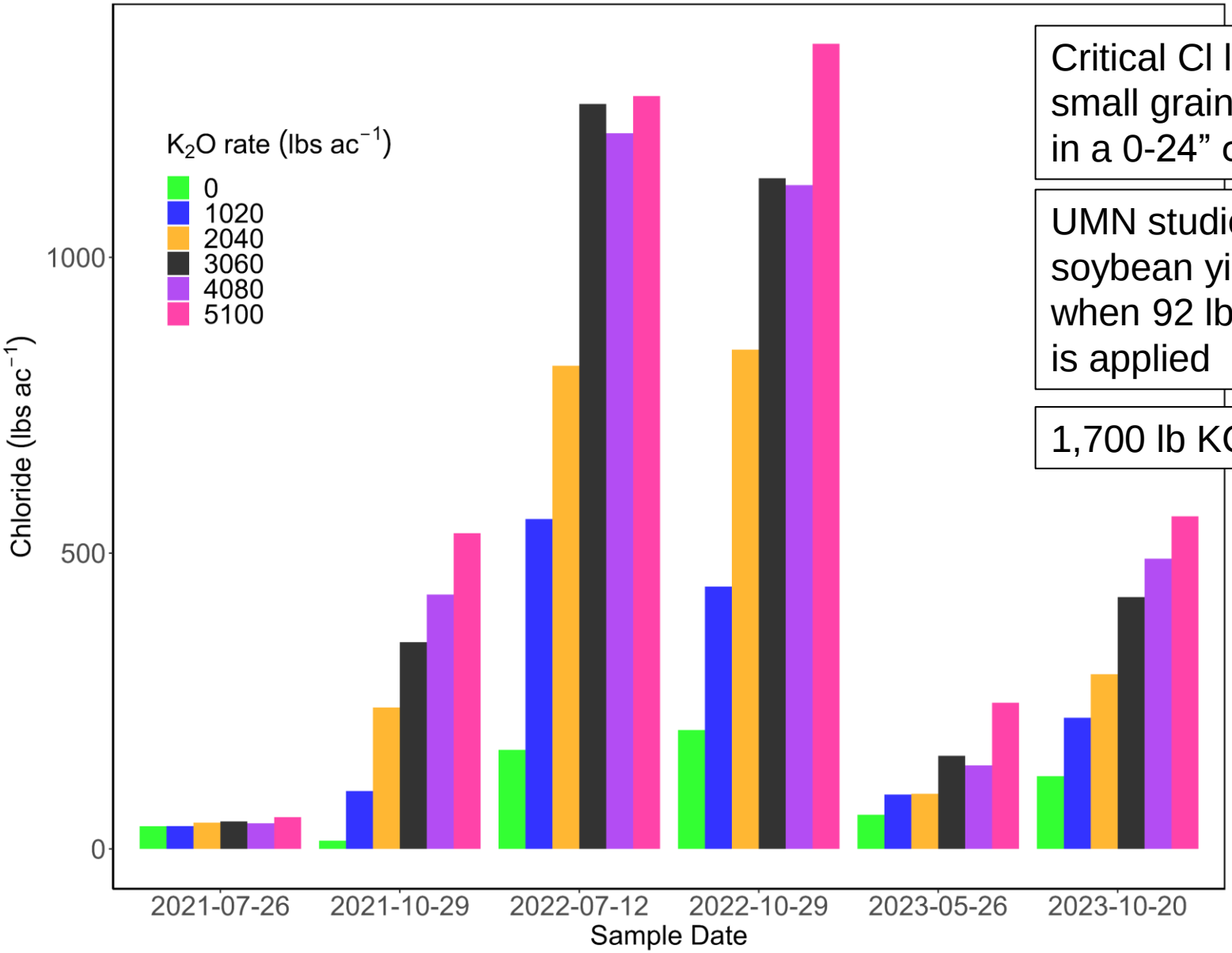

Not sure what the "real" number is???
3400 lb/acre potash (0-0-60)
K_2O rate (lbs ac^{-1})
0
1020
2040
3060
4080
5100
5% K
Base Saturation(%K)
0
2
4
6
8
2021-07-26
2021-10-29
2022-07-12
2022-10-29
2023-05-26
2023-10-20
Sample Date



Critical Cl level for small grains = 40 lb/A in a 0-24” core

UMN studies show soybean yield loss when 92 lb/A chloride is applied

1,700 lb KCl = 782 lb Cl

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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. 2022 (14 months)	Oct. 2023 (26 months)
Soil test P (Olsen)	15-20 lb/ 1 ppm	P_2O_5	7.2 lb/ppm	9.3 lb/ppm	18 lb/ppm
Soil test K	5-10 lb/ 1 ppm	K_2O	4.2 lb/ppm	4.2 lb/ppm	5.5 lb/ppm
K saturation	soil dependent	K_2O	660 lb/%	772 lb/%	827 lb/%

Phosphorus fixation is occurring. Soil test P will decline, resulting in the buffering capacity to increase over time and approach the expected range of 15-20 lb/ppm. Potassium sits close to the expected range of 5-10 lb/ppm.

Quick observations

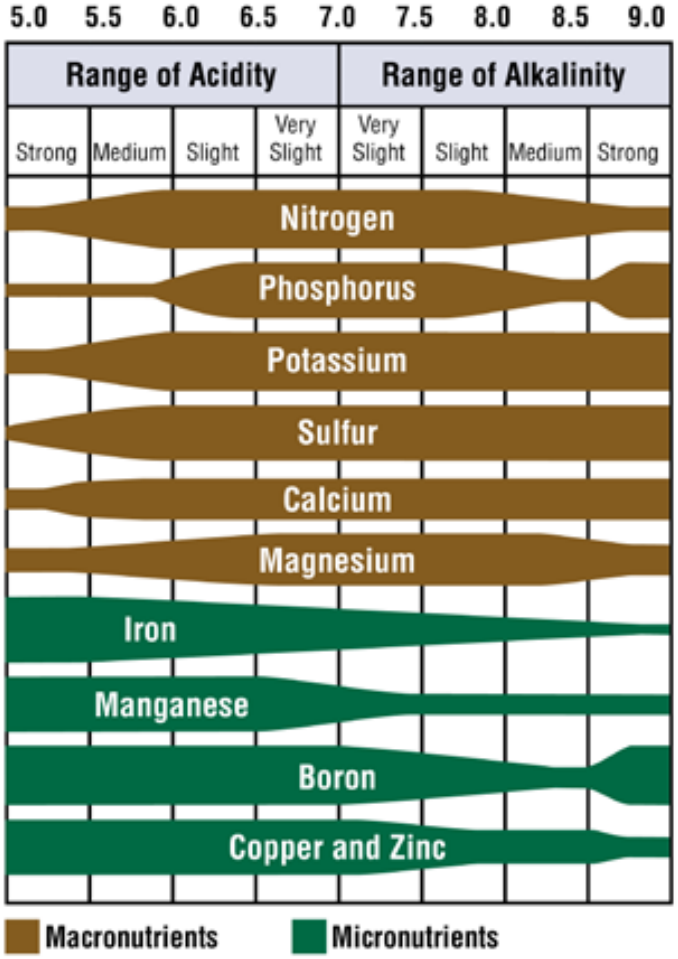
Phosphorus

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

Potassium

- Soil test K increased with increasing rate
- %K increased to 4-8% when high rates of K were applied
  - 3,400 – 8,500 lbs./ acre potash
- 100 years worth of K

Soil pH



Purdue Extension publication ID - 179

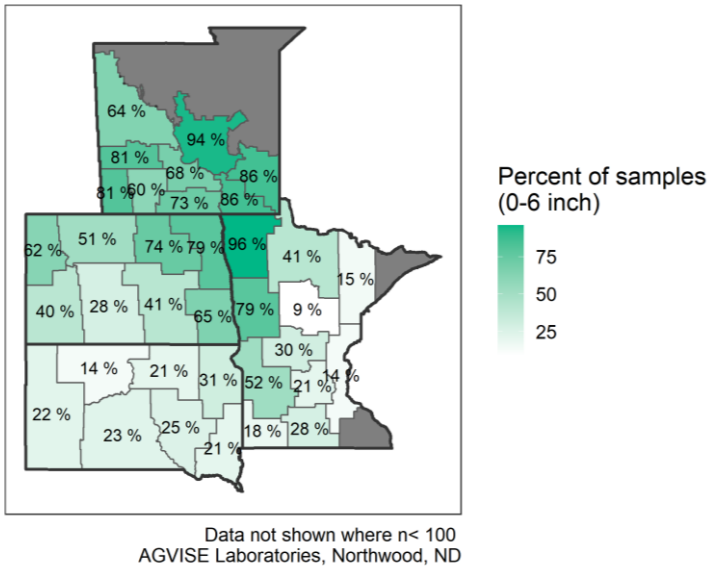
Atrazine carryover at pH > 6.8

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 2020



Data not shown where n< 100
AGVISE Laboratories, Northwood, ND

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

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

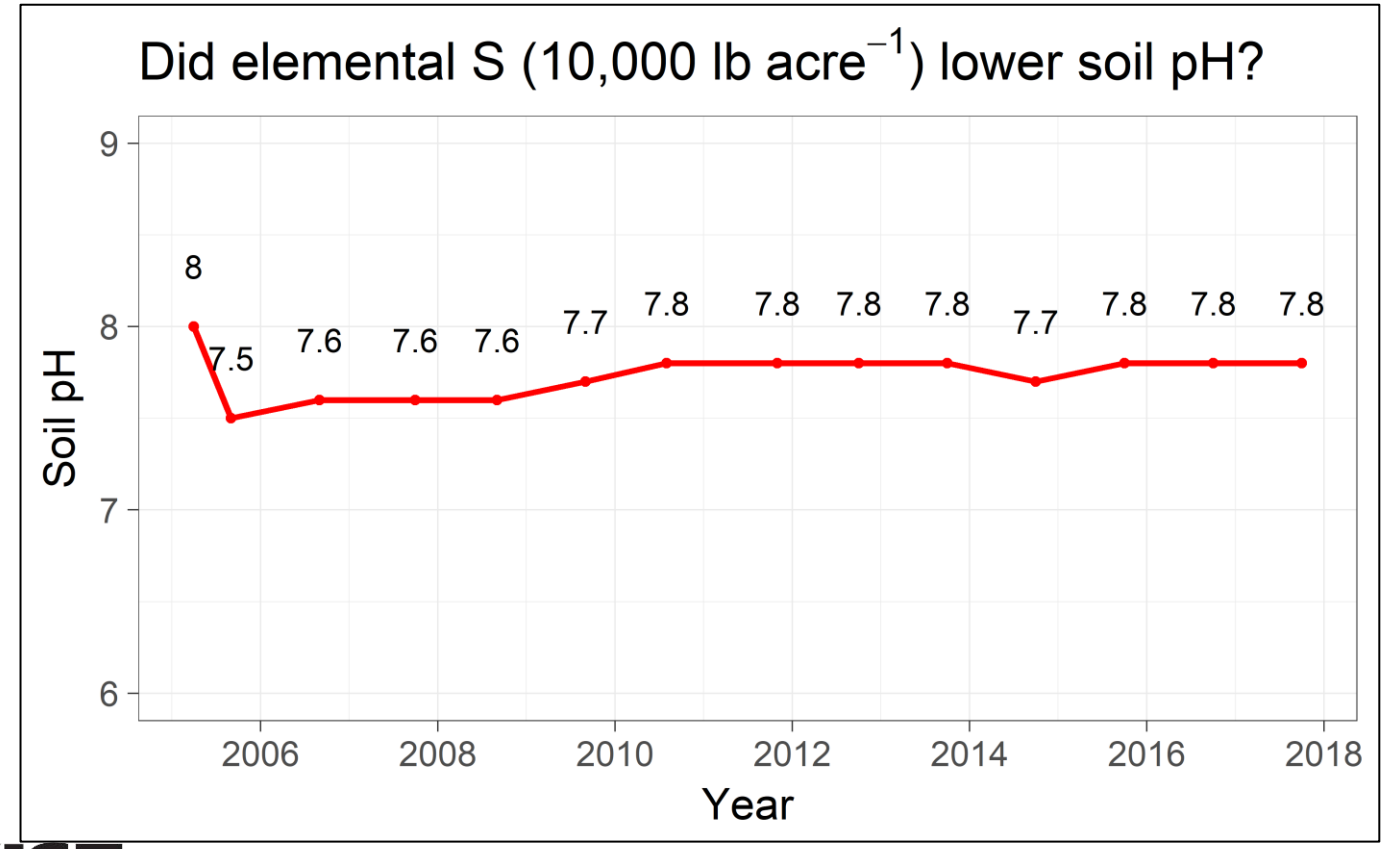
- Sulfuric acid produces H^+ ions, which can neutralize free lime in the soil
- Any other form of sulfur fertilizer (e.g. gypsum) is in the sulfate form of sulfur and CAN NOT neutralize free lime

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

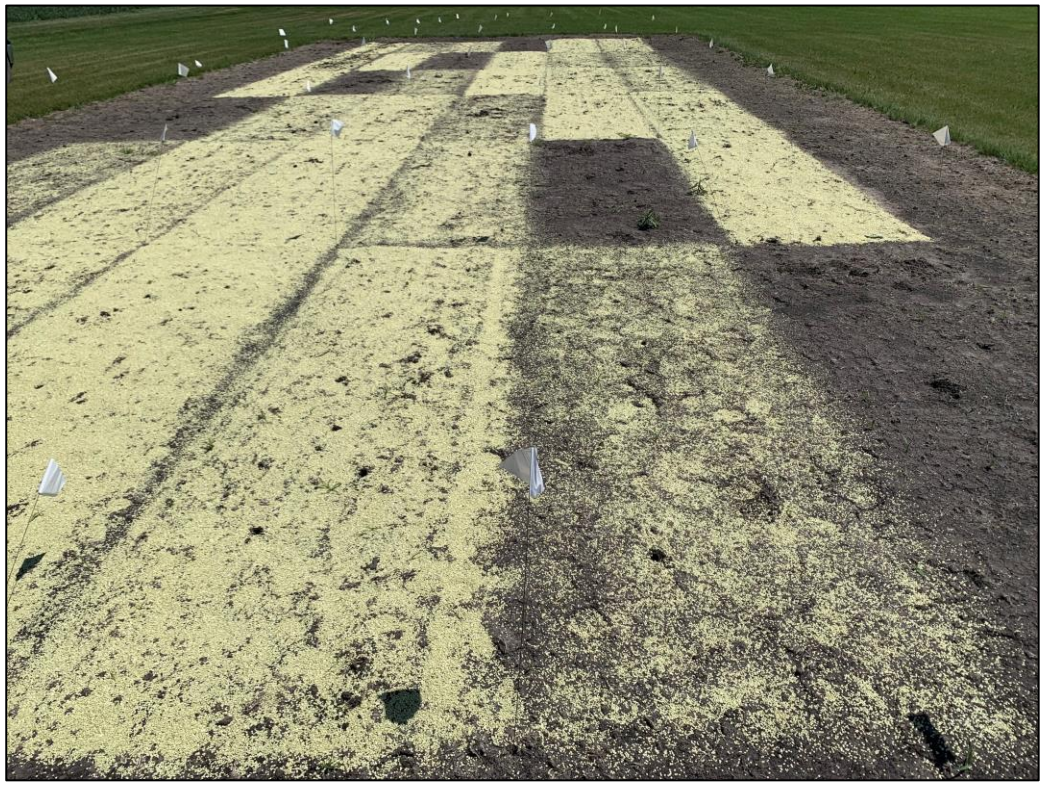


Again starting in 2020, with higher rates!

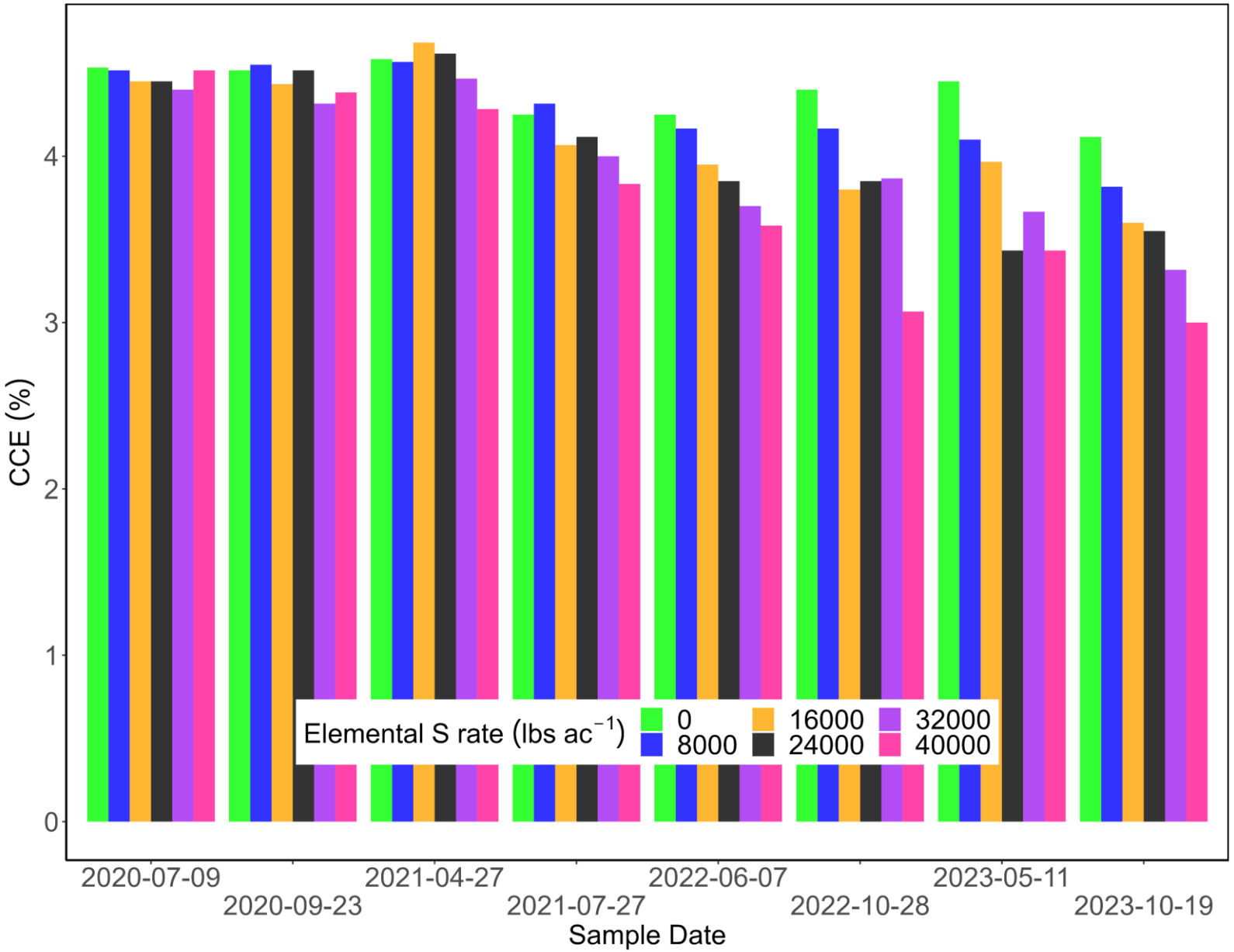
Objective: evaluate long-term effectiveness of elemental S as a soil amendment to reduce soil pH on a calcareous Northern Plains soil.

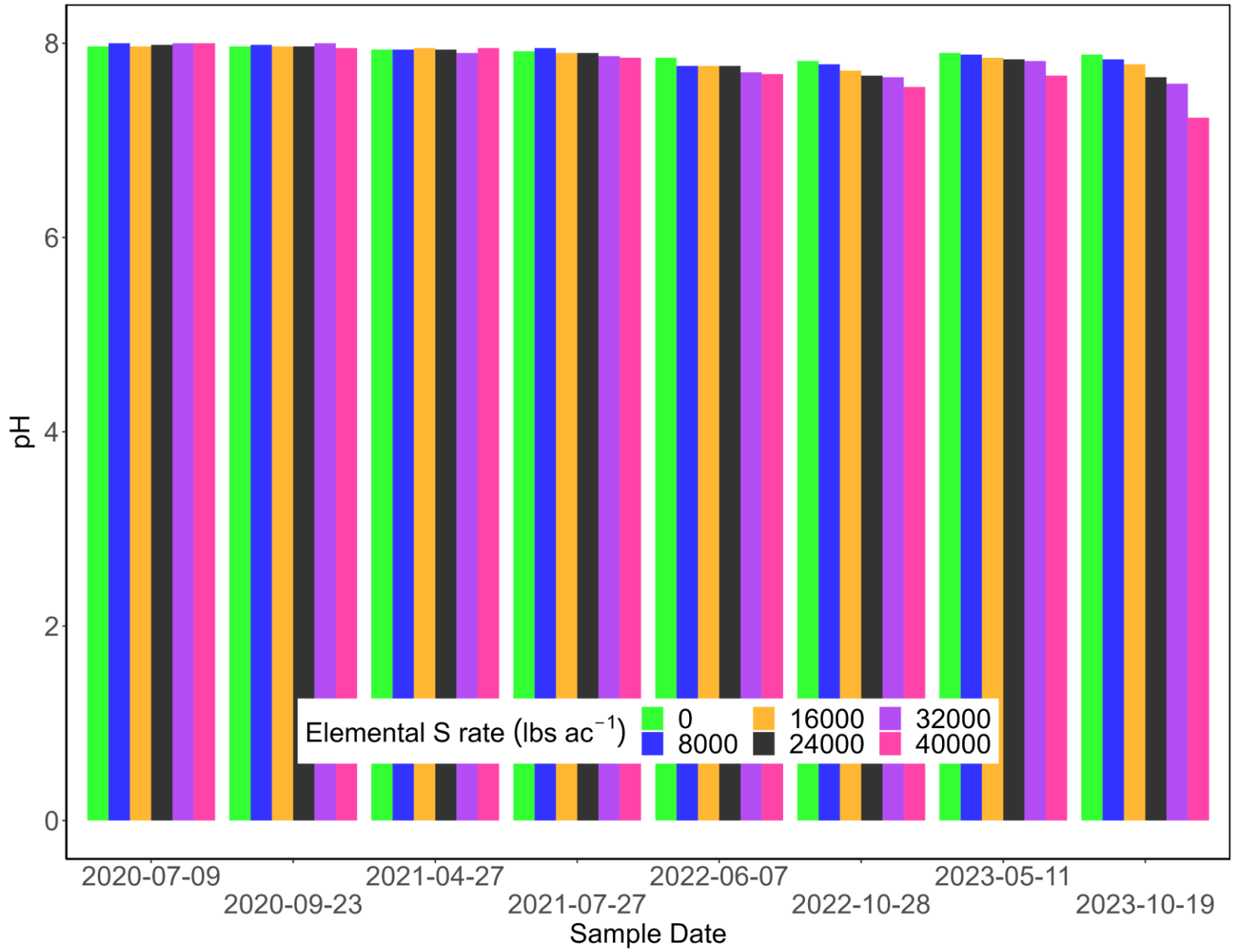
Site: Northwood, ND
Bearden silty clay loam, soil pH 8.0,
average **CCE: 4.5%**

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


CCE (%)
0
1
2
3
4
2020-07-09
2020-09-23
2021-04-27
2021-07-27
2022-06-07
2022-10-28
2023-05-11
2023-10-19
Sample Date
Elemental S rate (lbs ac^{-1})
0
8000
16000
24000
32000
40000


pH
8
6
4
2
0
Elemental S rate (lbs ac^{-1})
0
8000
16000
24000
32000
40000
2020-07-09
2020-09-23
2021-04-27
2021-07-27
2022-06-07
2022-10-28
2023-05-11
2023-10-19
Sample Date

Conclusion

- The process that turns elemental sulfur into sulfuric acid is biology driven; dry conditions in 2020 through 2021 slowed down any CCE% neutralization.
- Applying enough elemental sulfur to neutralize CCE and reduce pH is impractical on a field scale

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

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Question 4: Does time of day affect plant tissue results?

What did we find?

- Corn, wheat, and soybean collected on July 6, 2023 near Northwood, ND
- Plant part collected was the part appropriate for the growth stage
  - Wheat: flag leaf
  - Soybean: most recently fully developed leaf
  - Corn: most recently fully developed leaf
- Each “sample” a combination of leaves from 5 different areas within a uniform area of the field to reduce nutrient variation due to differences in the field.

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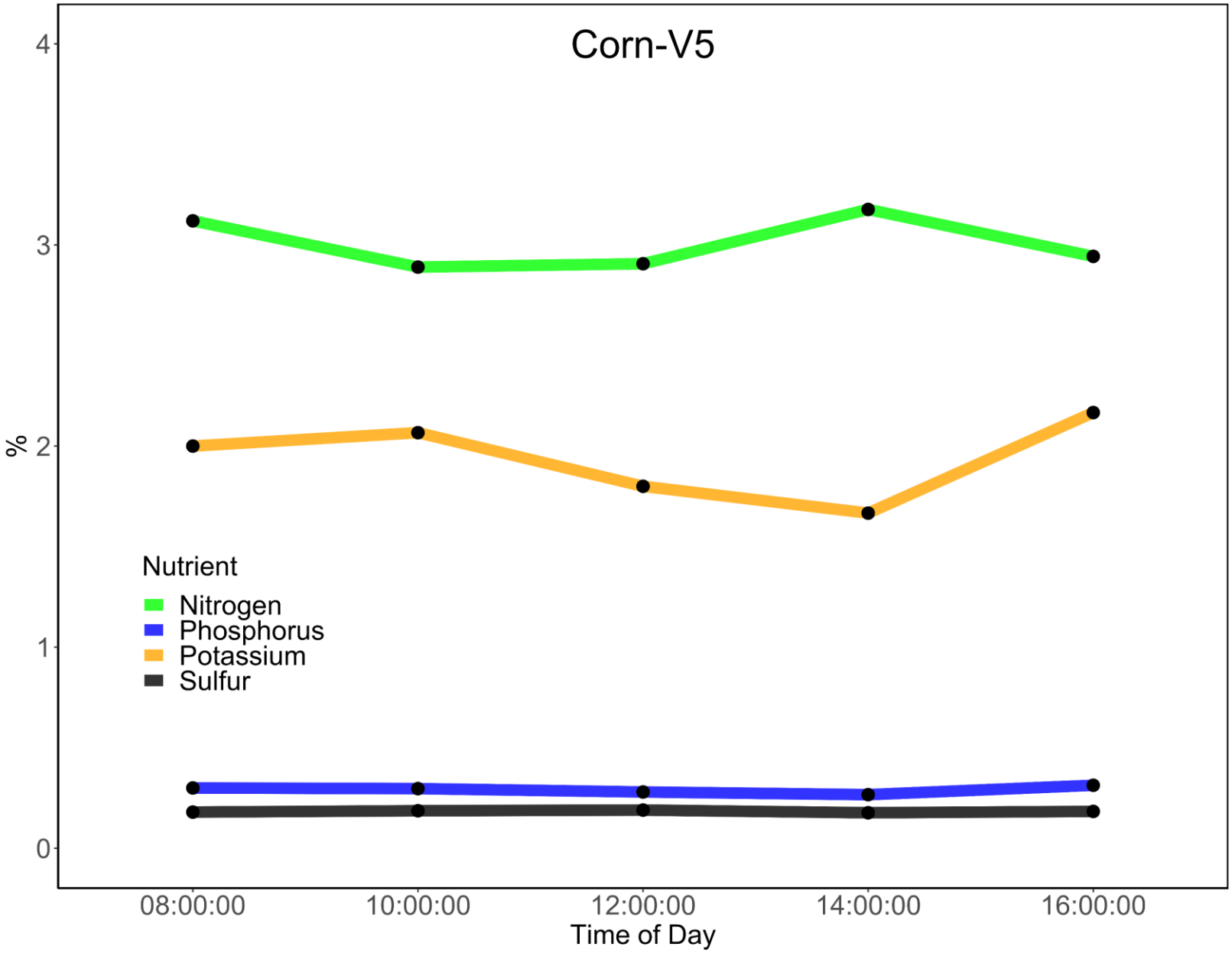
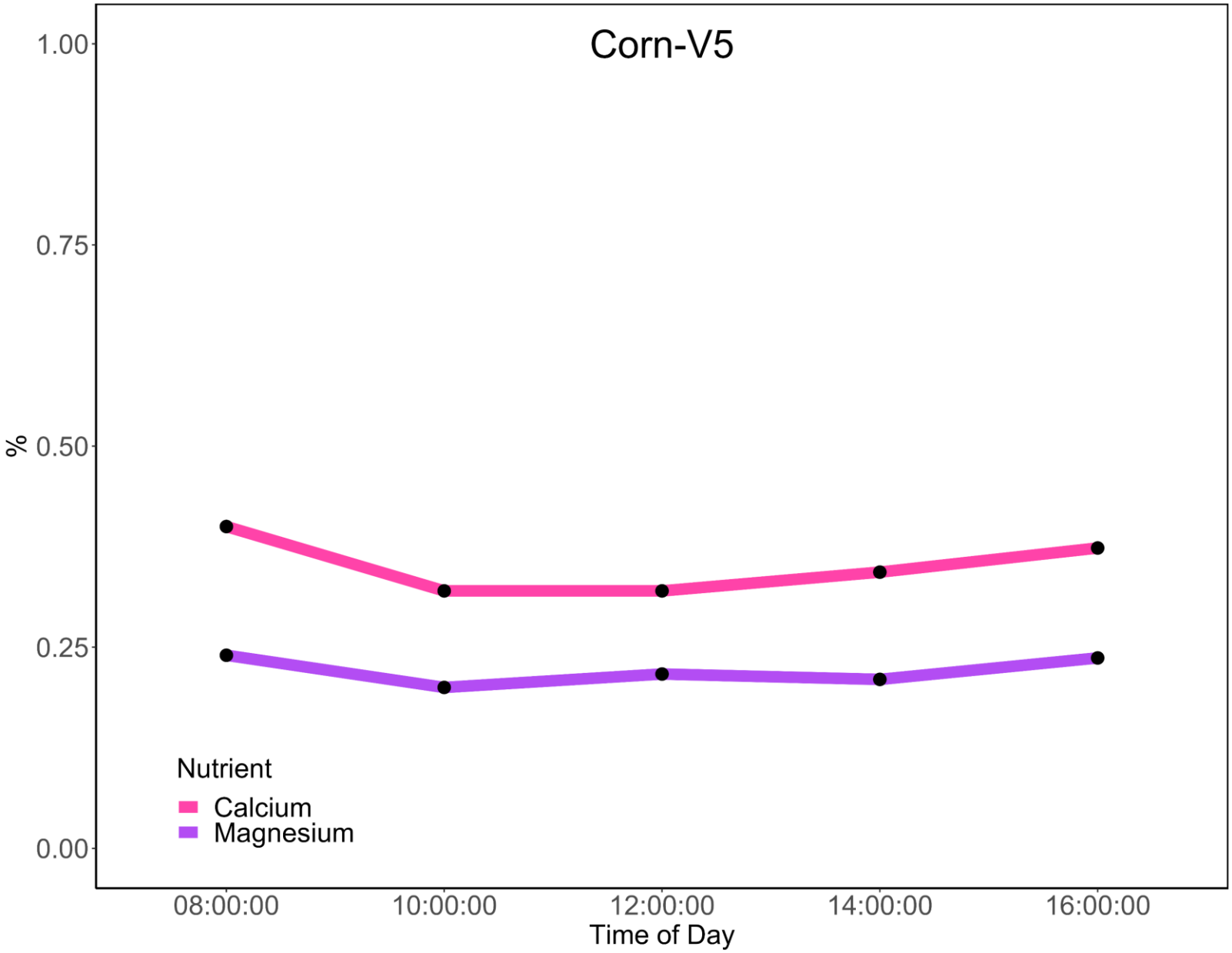
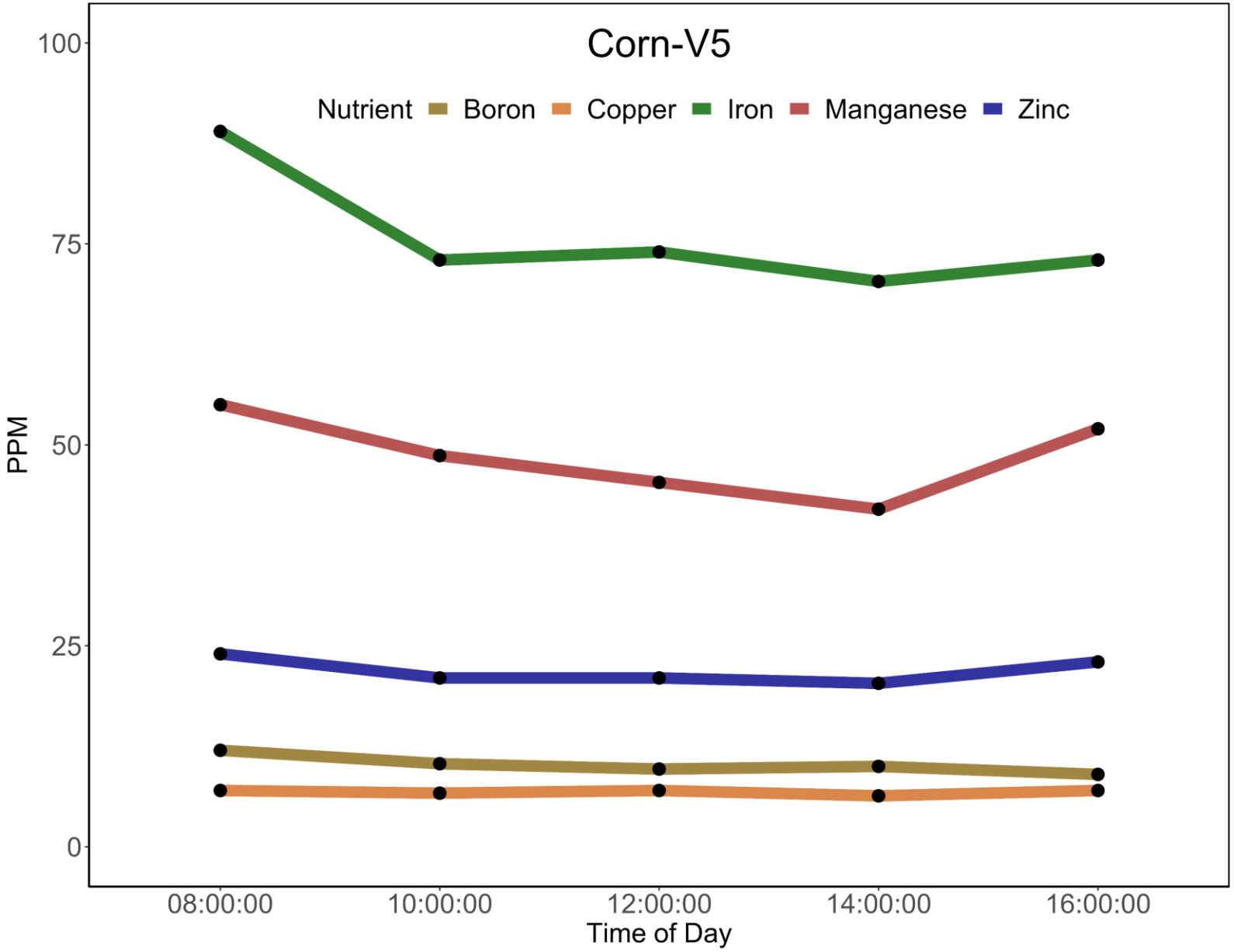

Corn-V5
4
3
2
1
0
%
Nutrient
Nitrogen
Phosphorus
Potassium
Sulfur
08:00:00
10:00:00
12:00:00
14:00:00
16:00:00
Time of Day


Corn-V5
1.00
0.75
0.50
0.25
0.00
%
Nutrient
Calcium
Magnesium
08:00:00
10:00:00
12:00:00
14:00:00
16:00:00
Time of Day



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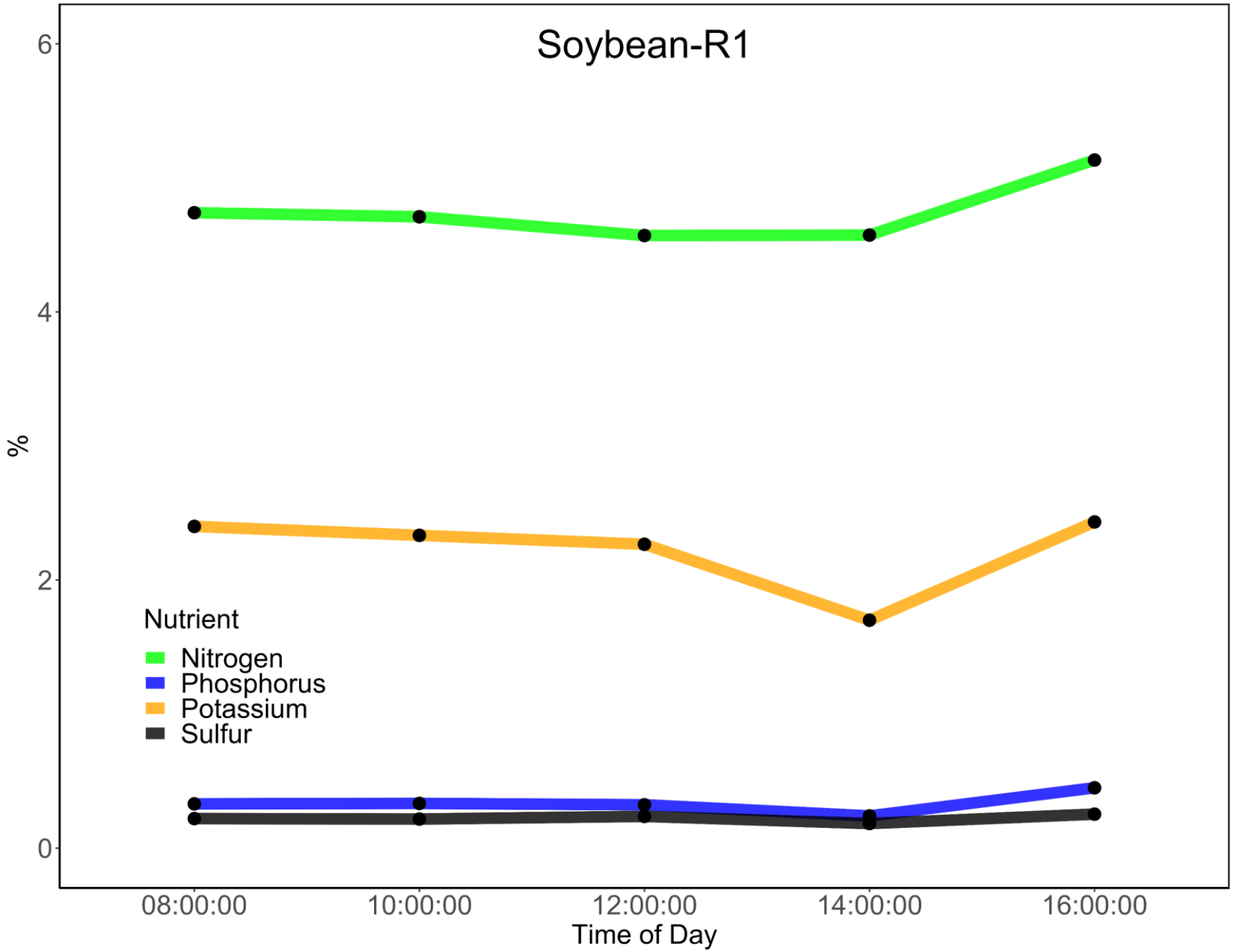
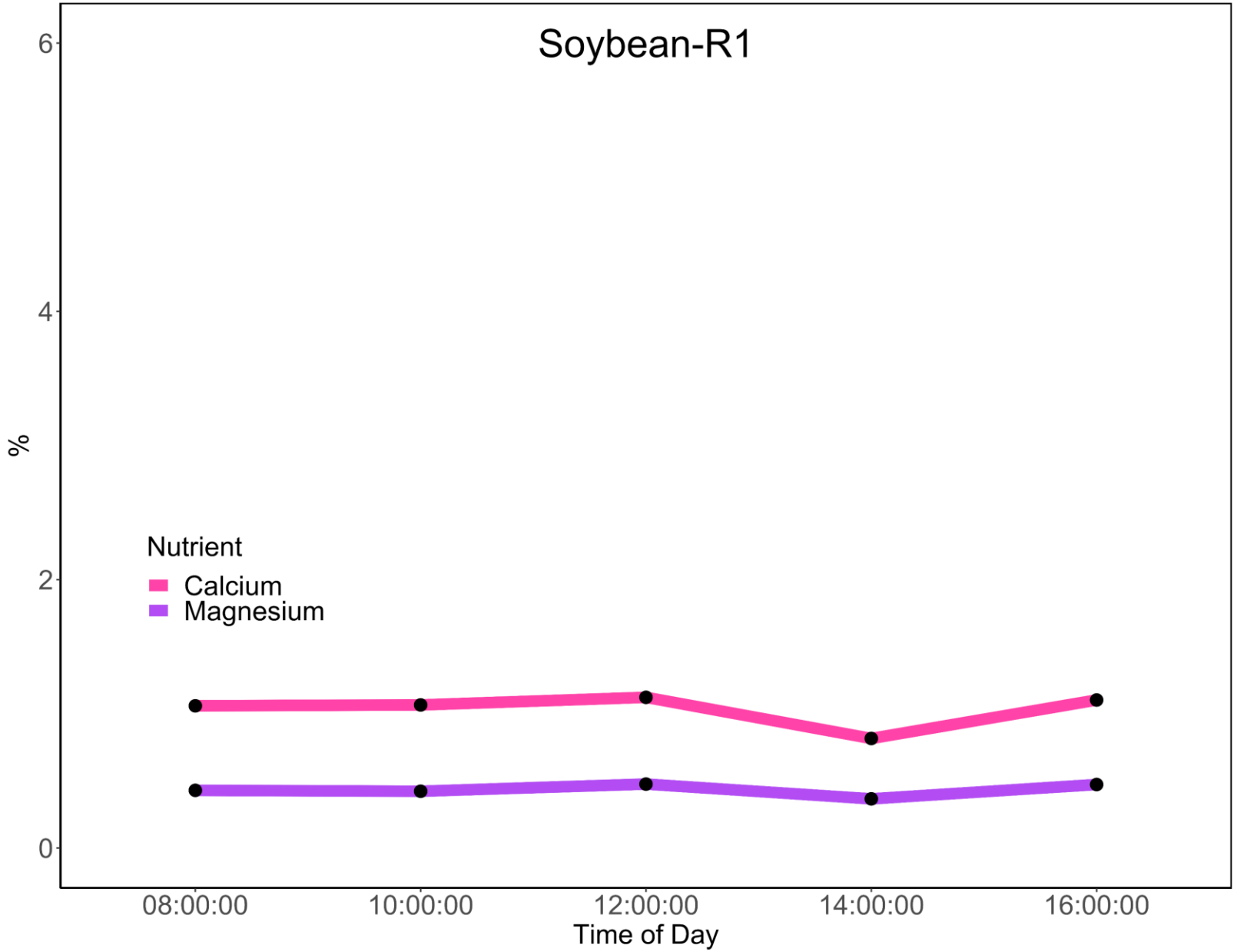
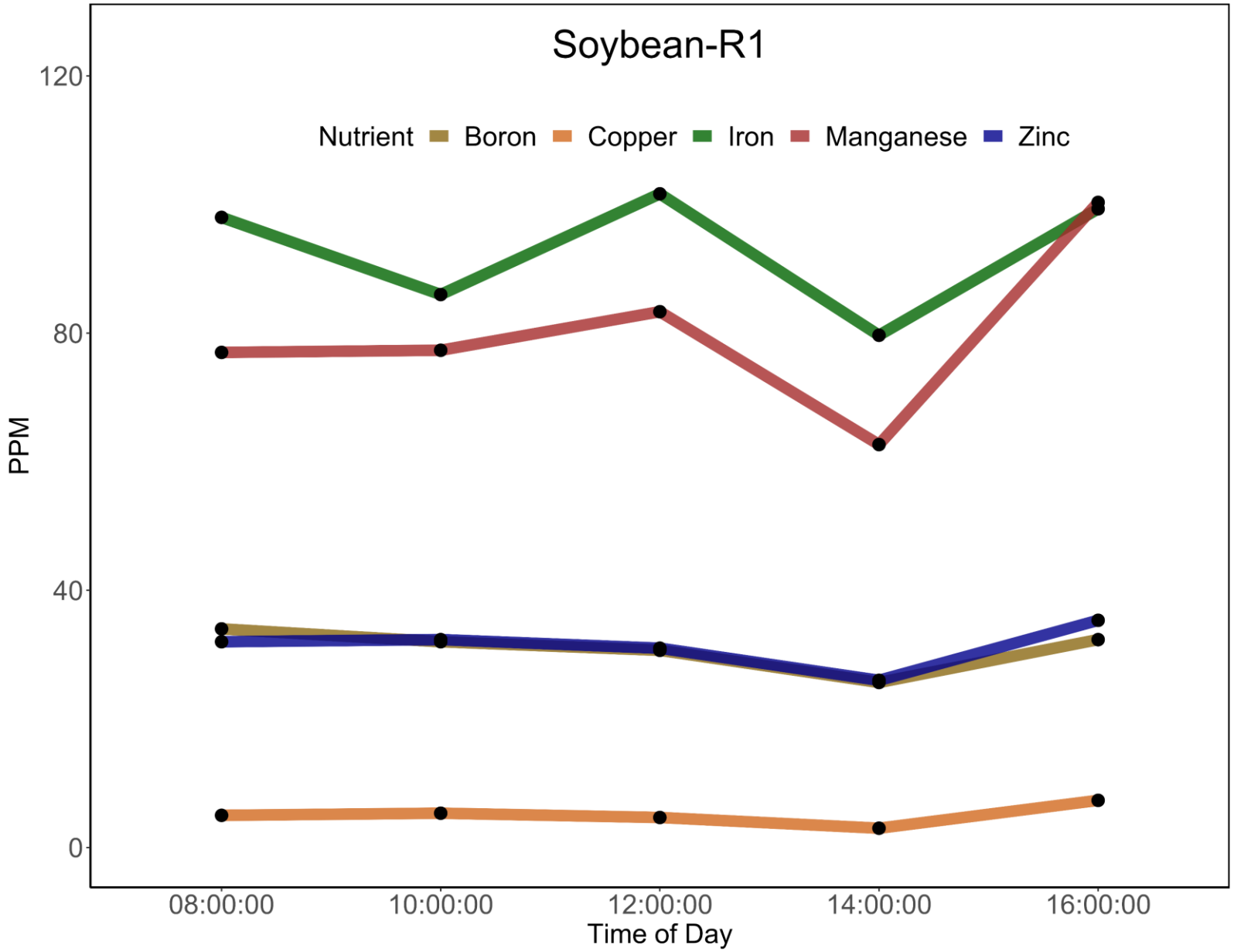
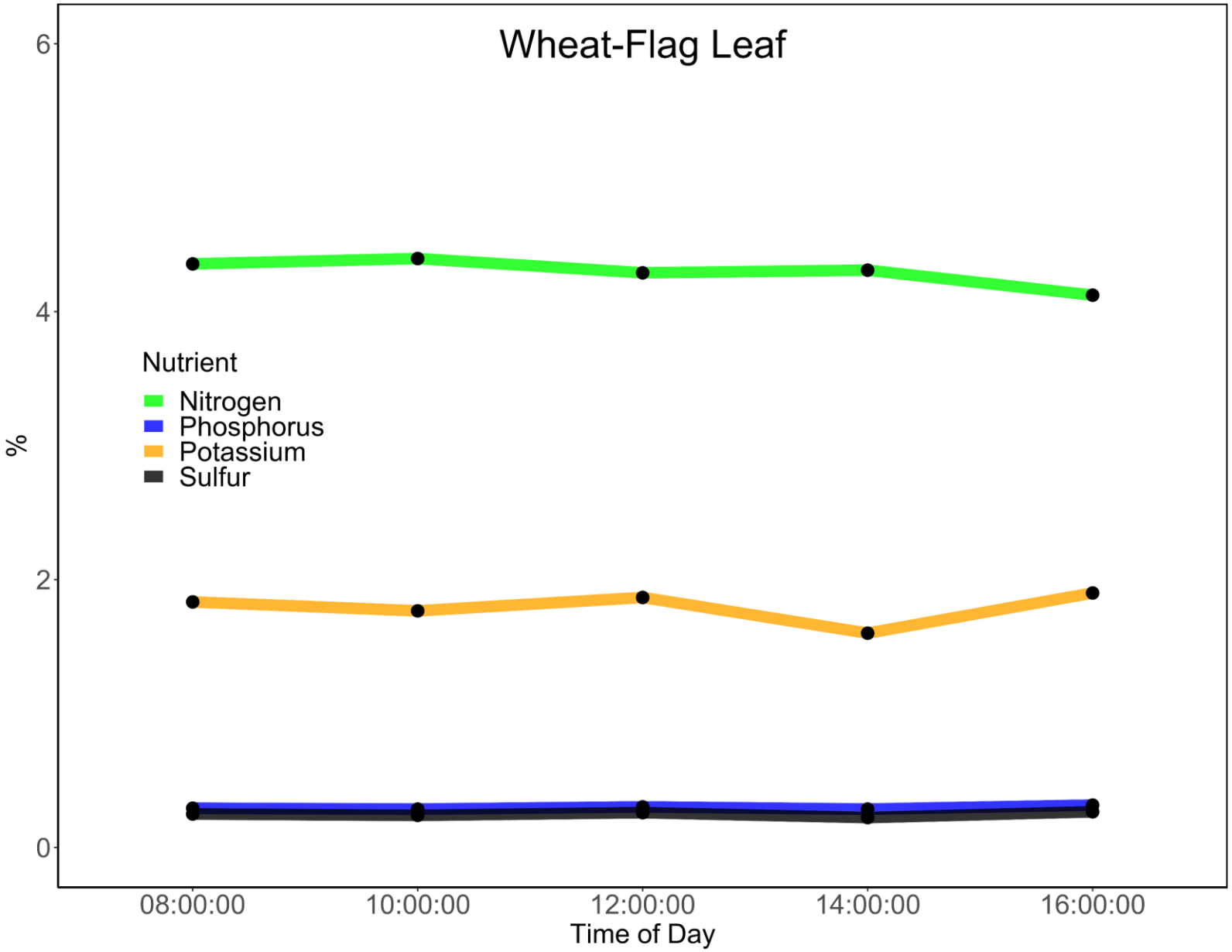
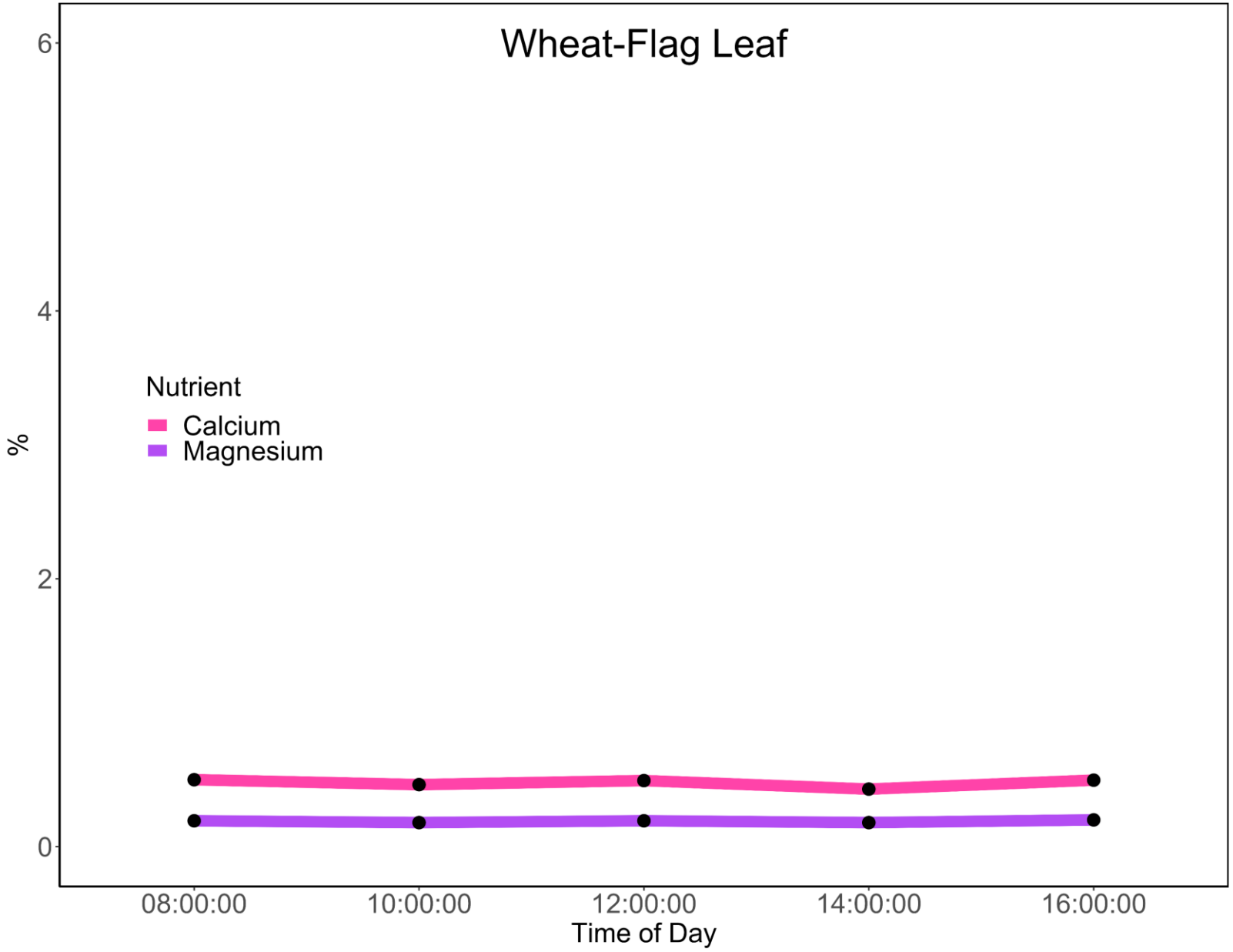
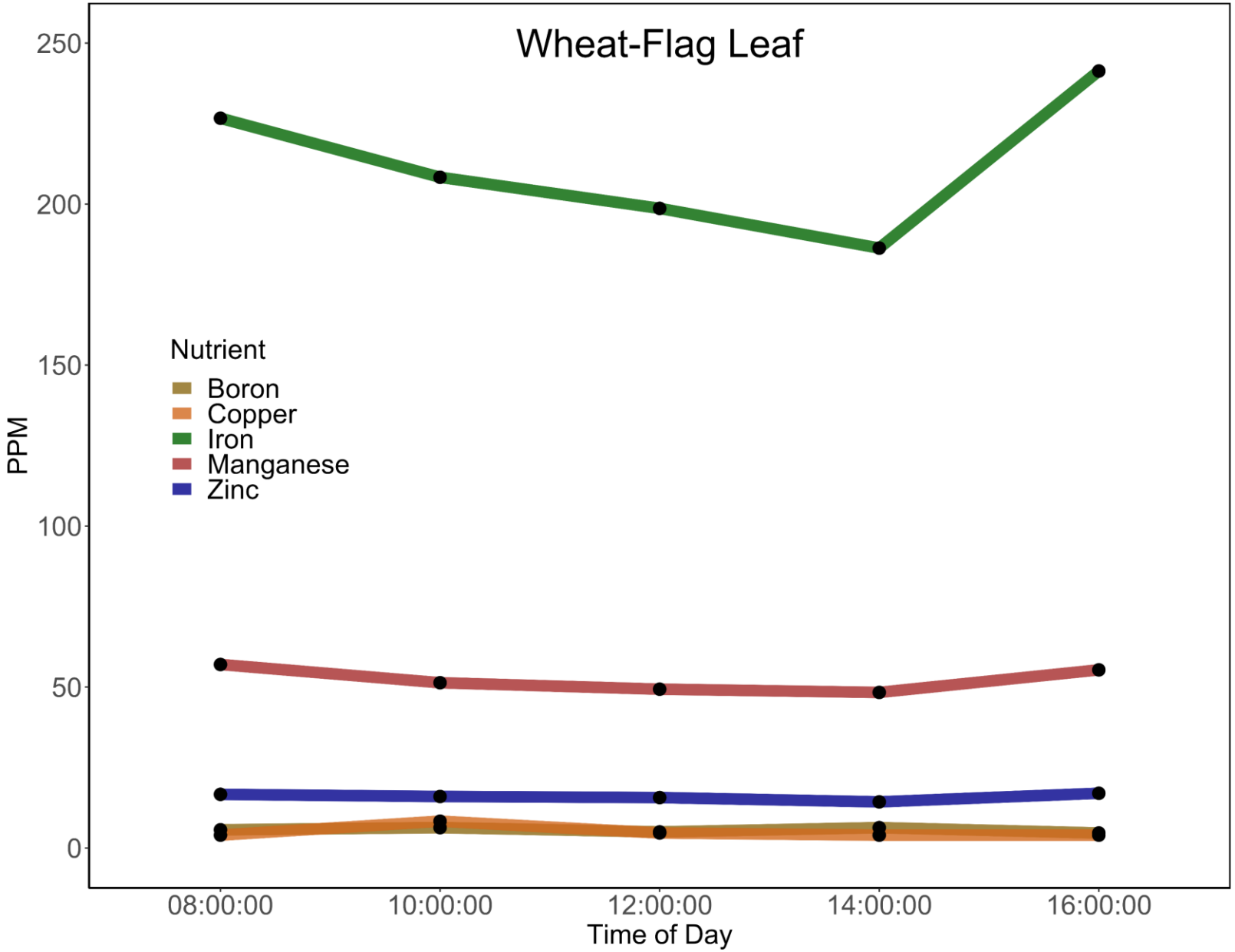

Soybean-R1
6
4
2
0
%
Nutrient
Nitrogen
Phosphorus
Potassium
Sulfur
08:00:00
10:00:00
12:00:00
14:00:00
16:00:00
Time of Day


Soybean-R1
6
4
2
0
%
Nutrient
Calcium
Magnesium
08:00:00
10:00:00
12:00:00
14:00:00
16:00:00
Time of Day


Soybean-R1
Nutrient
Boron
Copper
Iron
Manganese
Zinc
120
80
40
0
PPM
08:00:00
10:00:00
12:00:00
14:00:00
16:00:00
Time of Day


Wheat-Flag Leaf
6
4
2
0
%
Nutrient
Nitrogen
Phosphorus
Potassium
Sulfur
08:00:00
10:00:00
12:00:00
14:00:00
16:00:00
Time of Day


Wheat-Flag Leaf
6
4
2
0
%
Nutrient
Calcium
Magnesium
08:00:00
10:00:00
12:00:00
14:00:00
16:00:00
Time of Day


Wheat-Flag Leaf
250
200
150
100
50
0
PPM
Nutrient
Boron
Copper
Iron
Manganese
Zinc
08:00:00
10:00:00
12:00:00
14:00:00
16:00:00
Time of Day

Conclusions

- From our research, no effect on nutrient results in wheat, corn, soybean
  - Is that because we were sampling on a relatively mild day?
- Stay away from extreme conditions when collecting samples
- Don’t get caught up waiting for the “perfect time of day” to collect a sample

SCN in Dry Beans

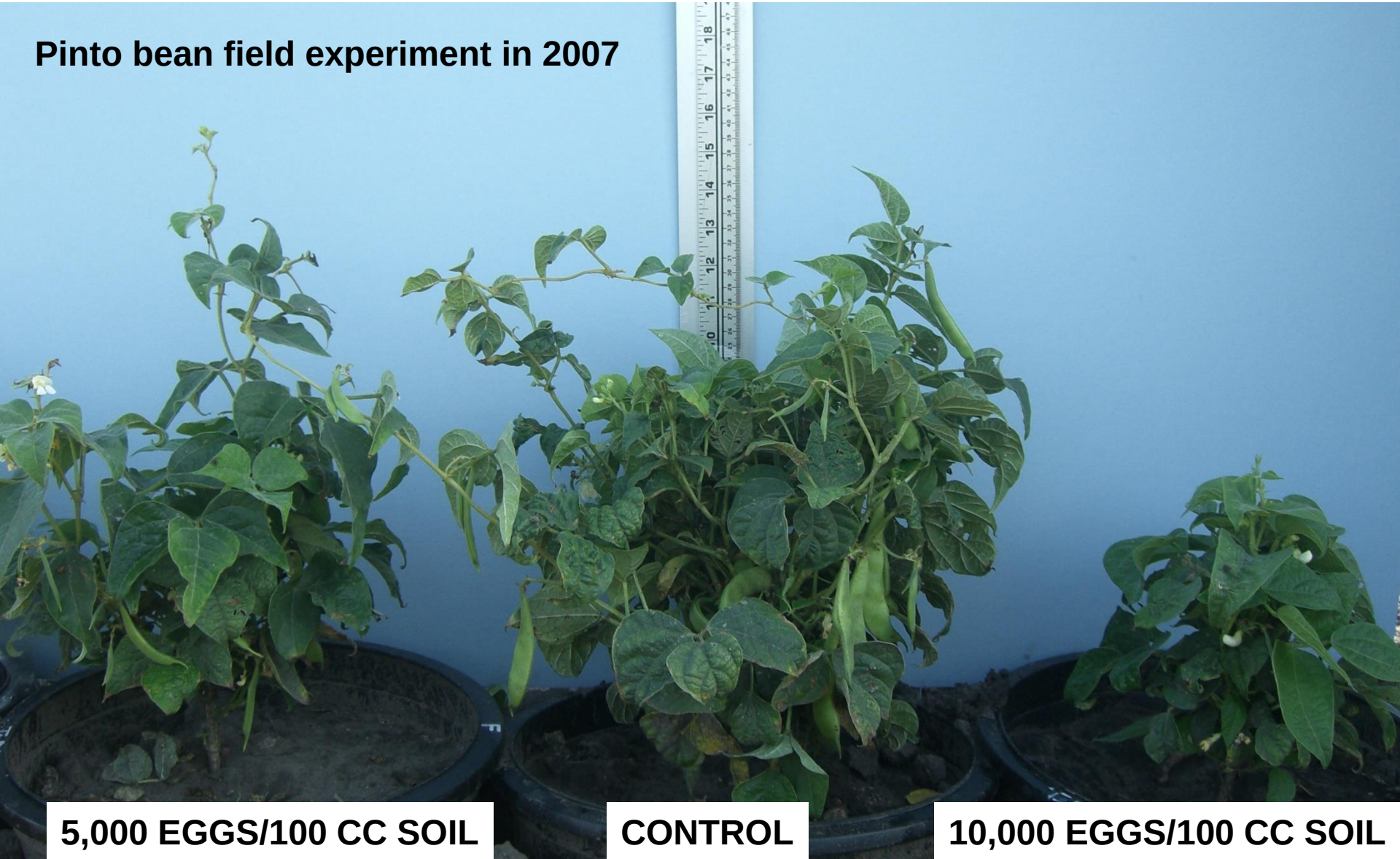
Soybean cyst nematode in dry bean

- Soil-borne pathogenic nematode feeds on soybean roots
- Up to 30% yield loss before visual symptoms appear
- Dry edible bean is another host plant and suffers yield loss

Stunted and yellow soybean from severe SCN infection

Chowdhury, I.A., G. Yan, J. Halvorson, A. Thapa, M. Halvorson, and S. Markell. 2022. Soybean cyst nematode (SCN). NDSU Ext. Circ. PP1732. North Dakota State Univ., Fargo, ND.

EFFECT OF SCN ON GROWTH OF DRY BEAN (Courtesy Berlin Nelson)



Soybean cyst nematode management

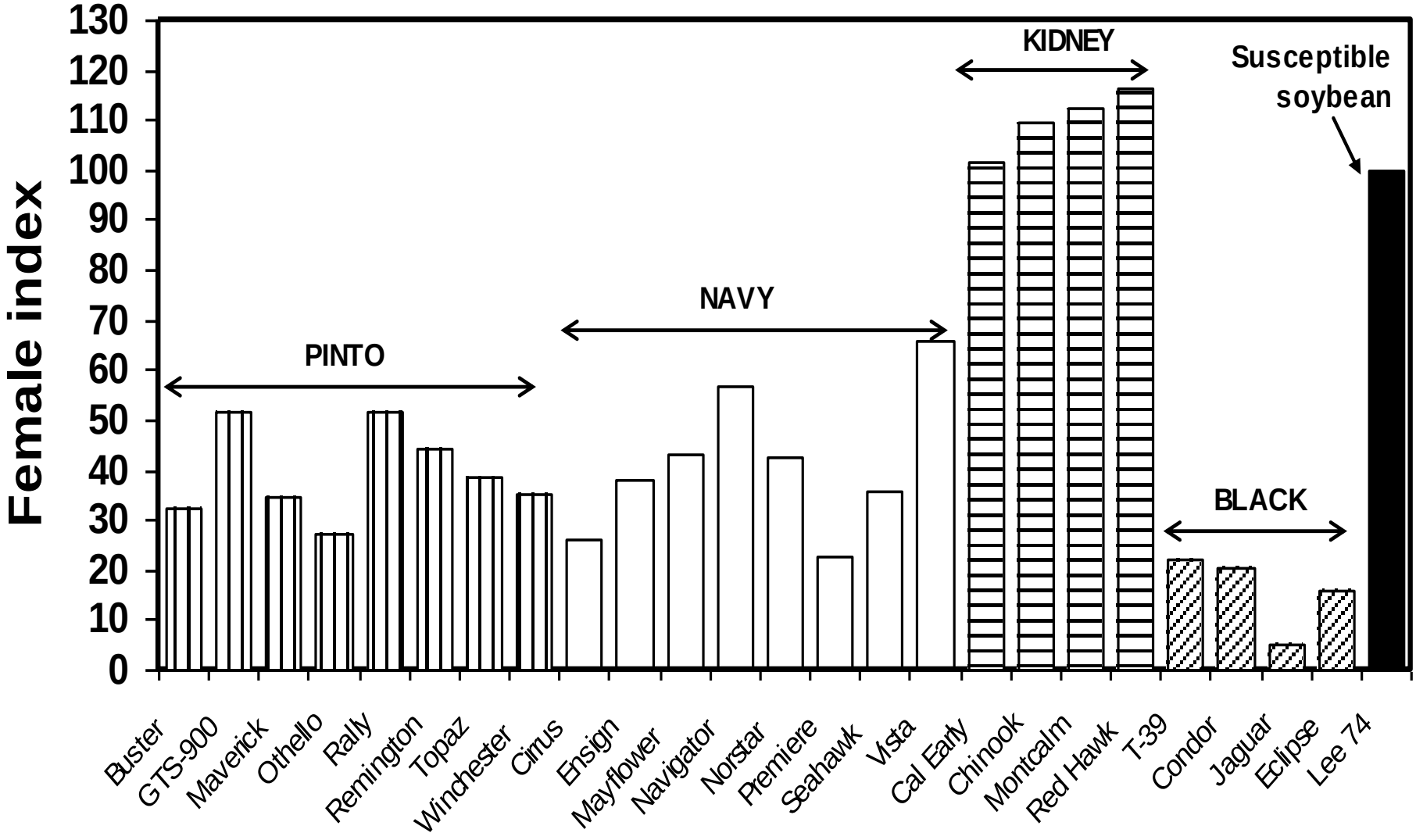
Soil sampling for SCN is the best detection and monitoring tool

SCN population (eggs/100 cc soil)	Management
<200	Susceptible soybean variety
200 to 10,000	Resistant soybean variety
>10,000	Non-host crop

No thresholds for dry bean or breeding for genetic resistance

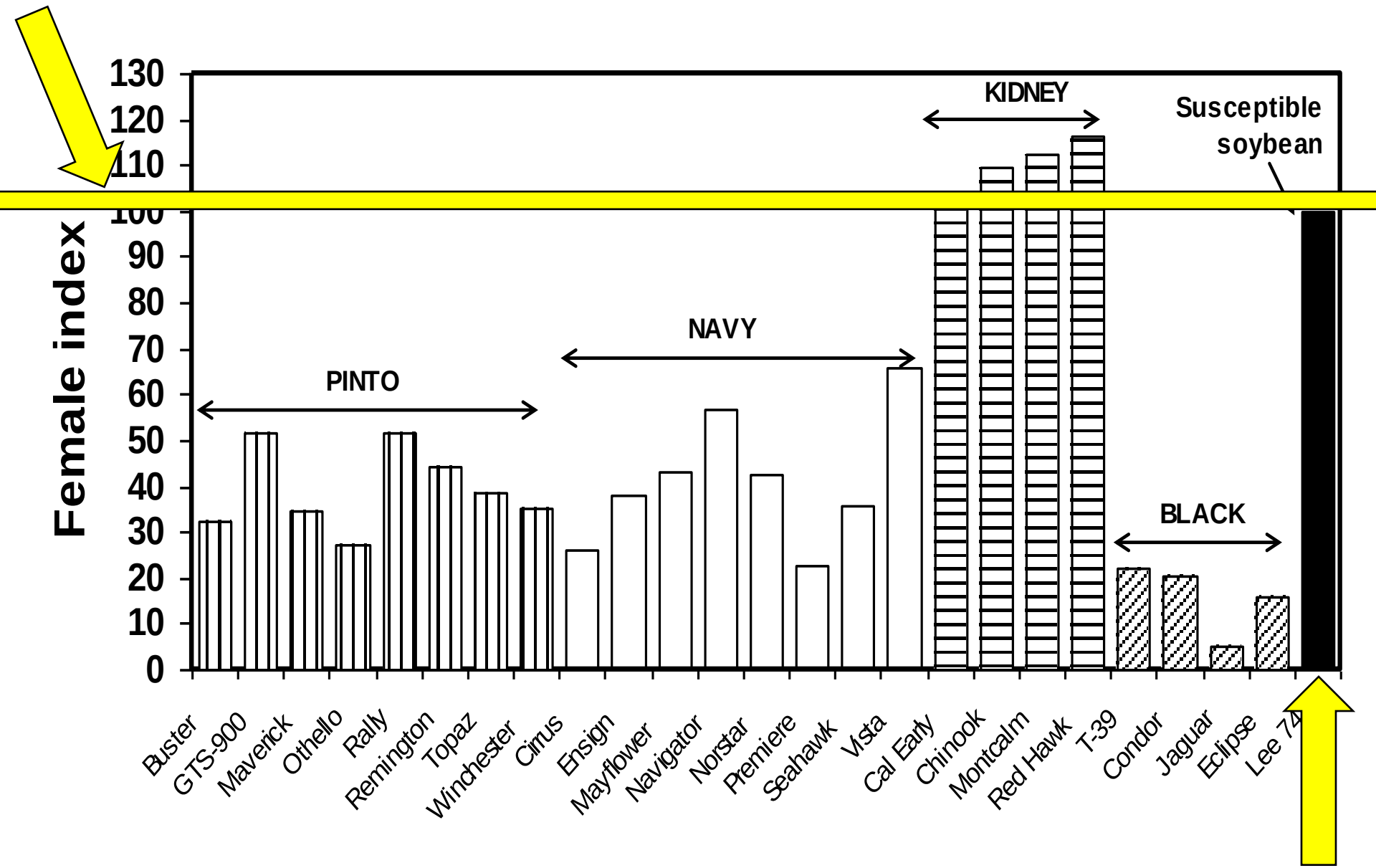
Cream-colored and lemon-shaped females (cysts) with eggs

Chowdhury, I.A., G. Yan, J. Halvorson, A. Thapa, M. Halvorson, and S. Markell. 2022. Soybean cyst nematode (SCN). NDSU Ext. Circ. PP1732. North Dakota State Univ., Fargo, ND.



Female Index (FI) is used to rate resistance/susceptibility to SCN in soybean.
FI<10 = resistant; FI 10-30 = moderately resistant; FI 31-60 moderately susceptible; FI>60 susceptible.

Courtesy Berlin Nelson

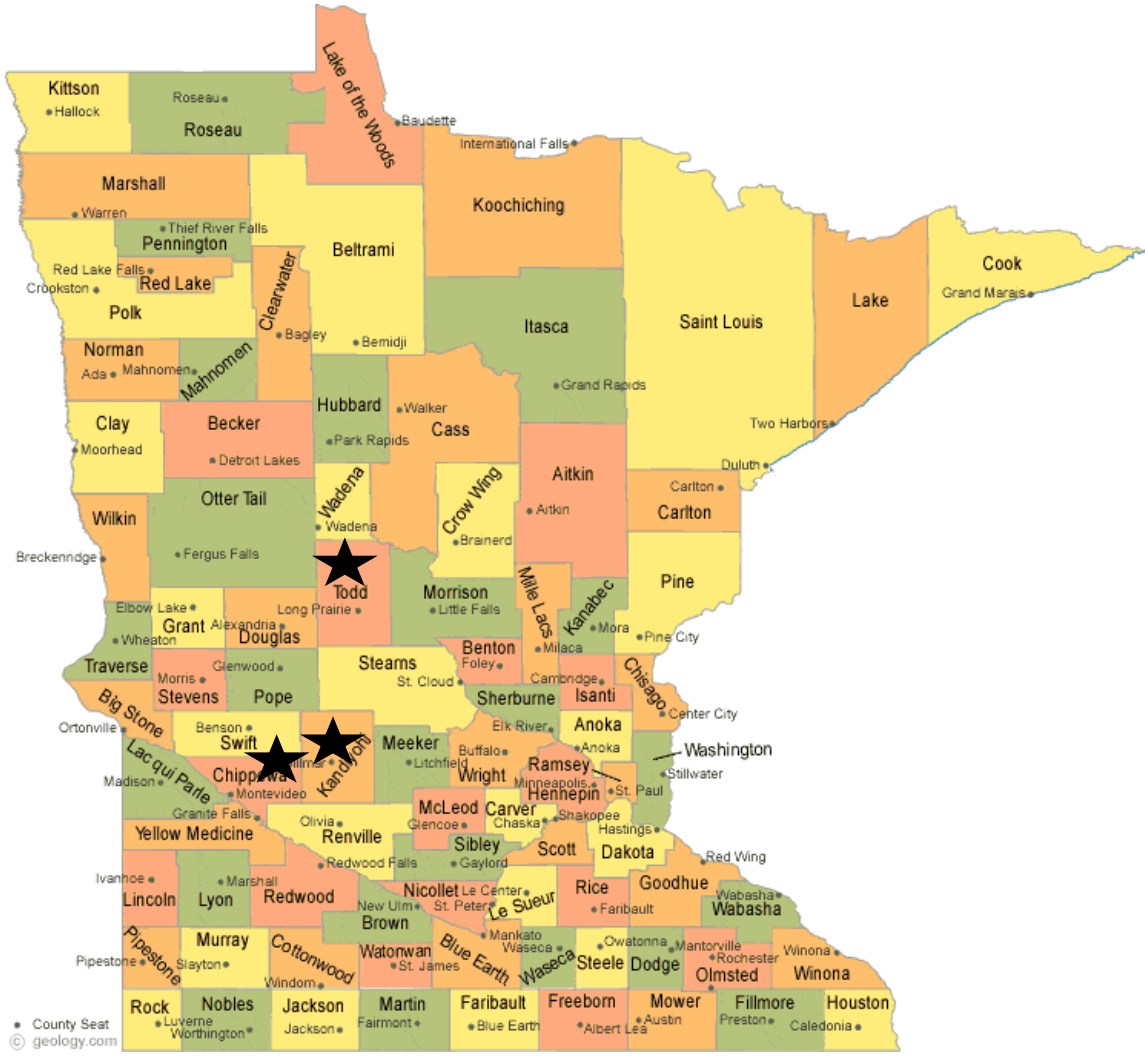


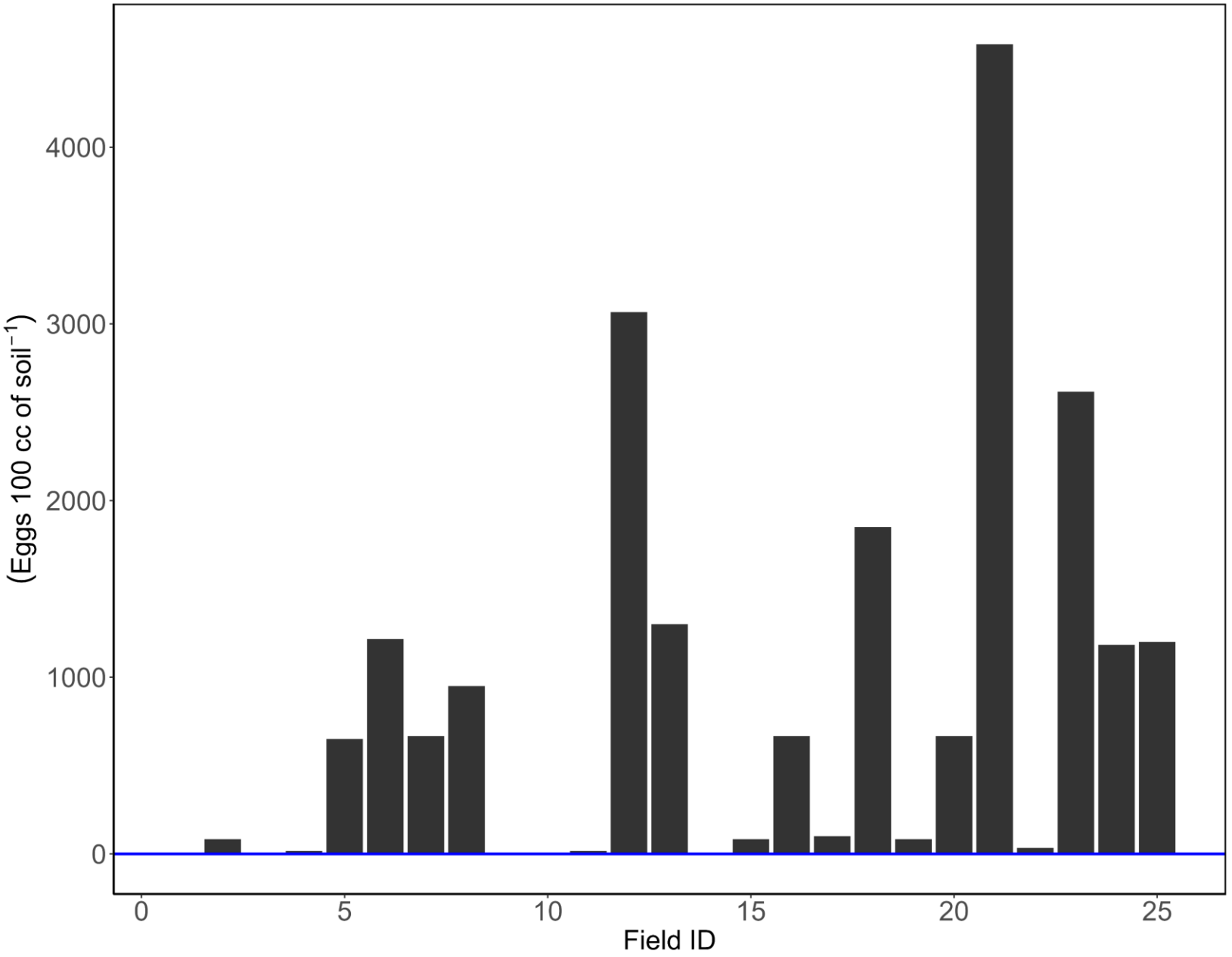
Female Index (FI) is used to rate resistance/susceptibility to SCN in soybean.
FI<10 = resistant; FI 10-30 = moderately resistant; FI 31-60 moderately susceptible; FI>60 susceptible.

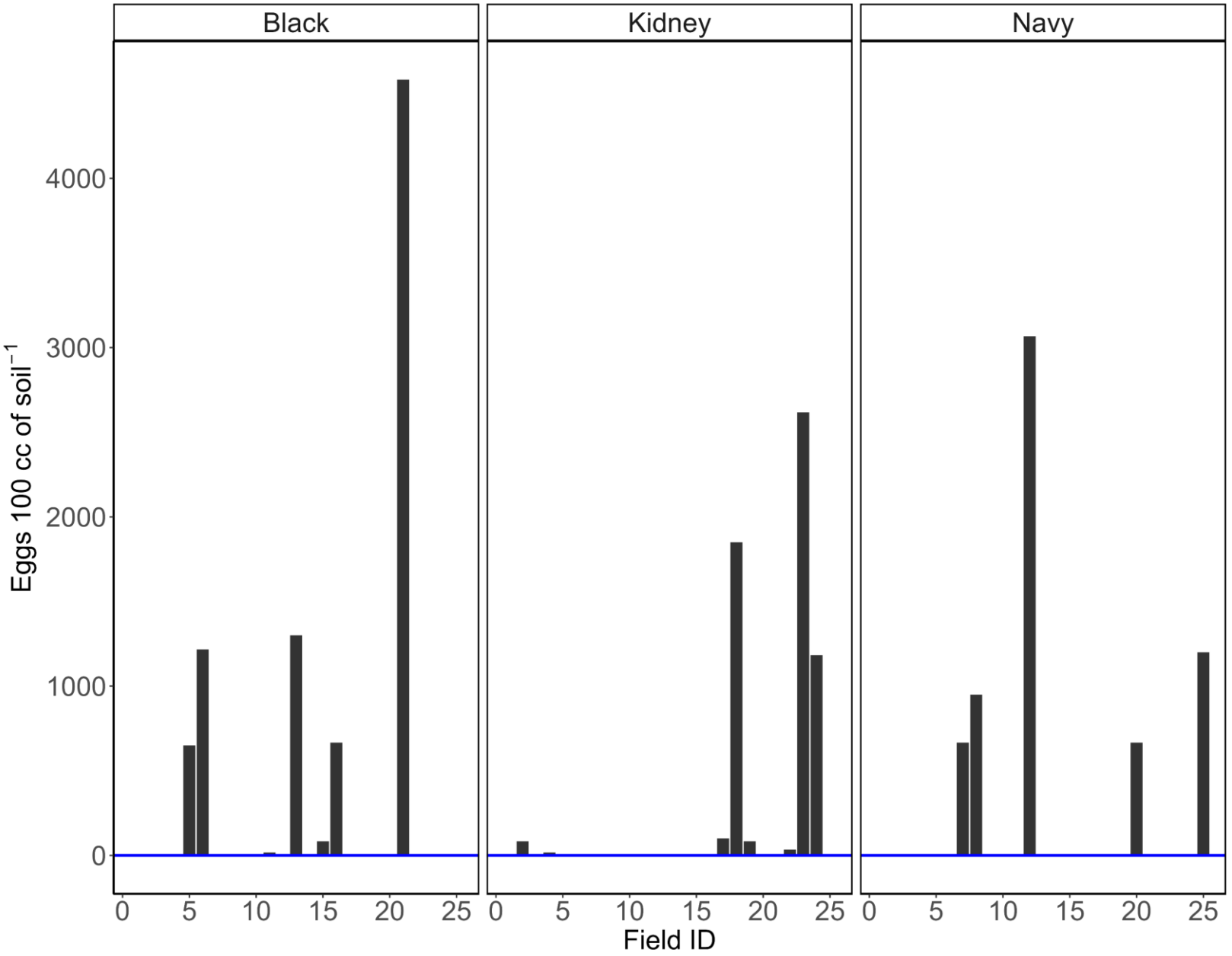
Courtesy Berlin Nelson

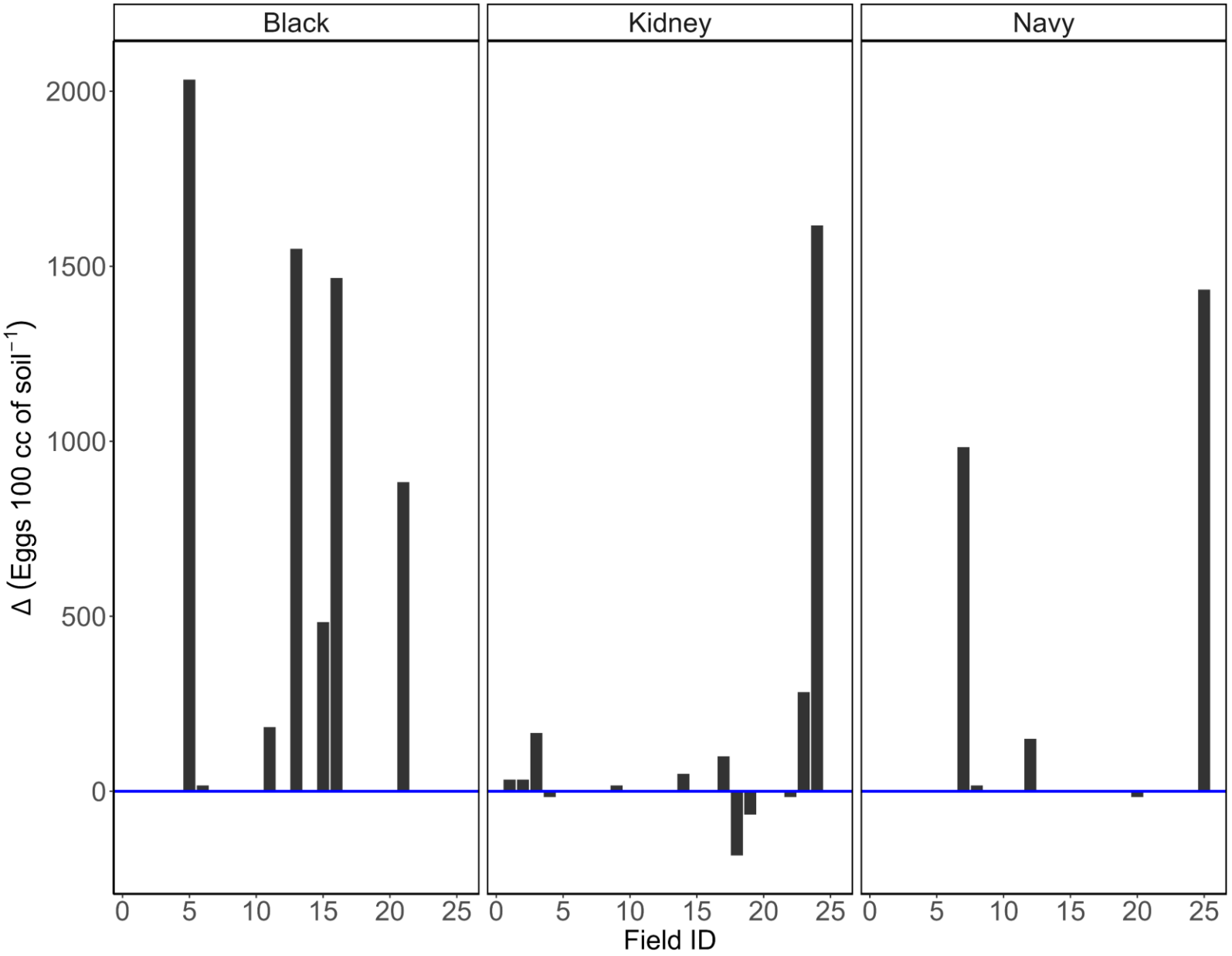
SCN Project

- 2 years (2022, 2023)
- 25 fields
- 3 different dry beans:
  - Kidney
  - Black
  - Navy
- Egg counts
  - July
  - Harvest




4000
3000
2000
1000
0
(Eggs 100 cc of soil^{-1})
0
5
10
15
20
25
Field ID

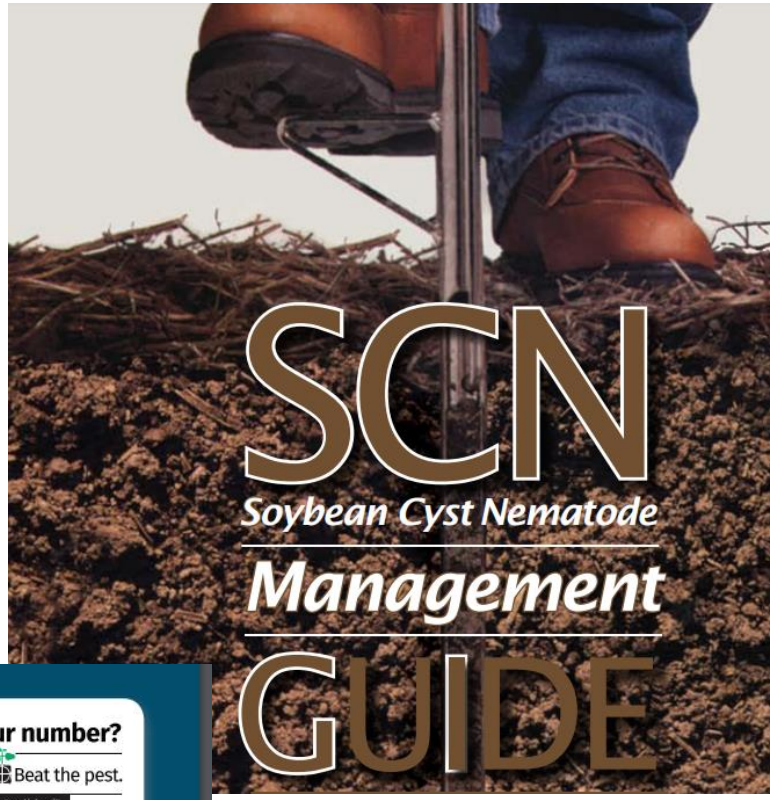

Black
Kidney
Navy
Eggs 100 cc of soil^{-1}
0
1000
2000
3000
4000
0
5
10
15
20
25
Field ID

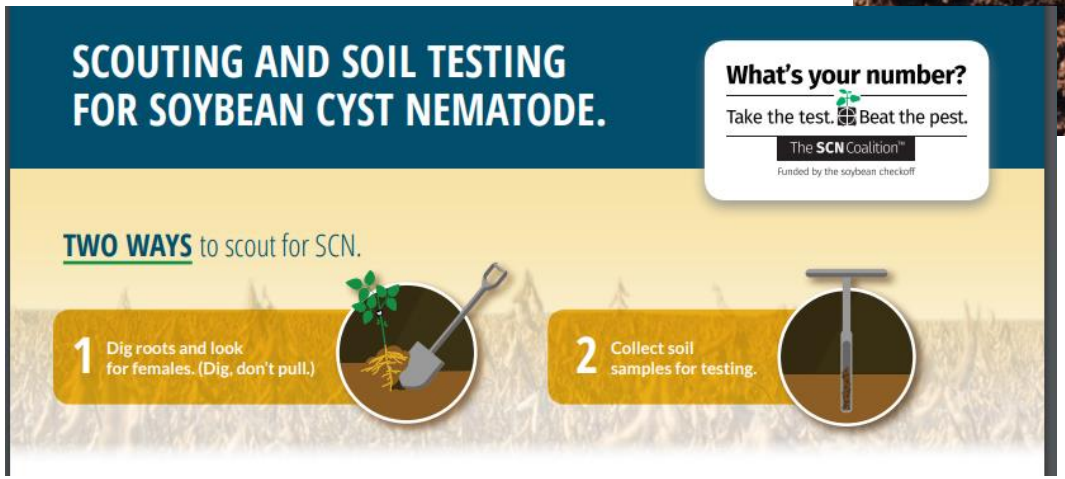

Black
Kidney
Navy
2000
1500
1000
500
0
Δ (Eggs 100 cc of soil^{-1})
0
5
10
15
20
25
Field ID

Soybean cyst nematode in dry bean

- No genetic resistance known in dry bean
- No nematicides for SCN labelled in dry bean
- Prevention is key to keep SCN population low
  - Prevent contamination with SCN-infested soil
  - Control SCN in soybean with resistance varieties and crop rotation (easiest and hardest thing to do)
  - Monitor SCN control measures for efficacy with spring vs. fall SCN comparisons

Going Forward: Start/Continue Sampling for SCN





Questions

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