

Nitrogen, Sulfur, and Hybrid Nutrient Use Interactions of Corn

Daniel J. Quinn, Ph.D

Assistant Professor of Agronomy

Extension Corn Specialist

Email: djquinn@purdue.edu

Web: thekernel.info

Twitter/X: @PurdueCorn



12/16/25

© D.J. Quinn, Purdue University

1

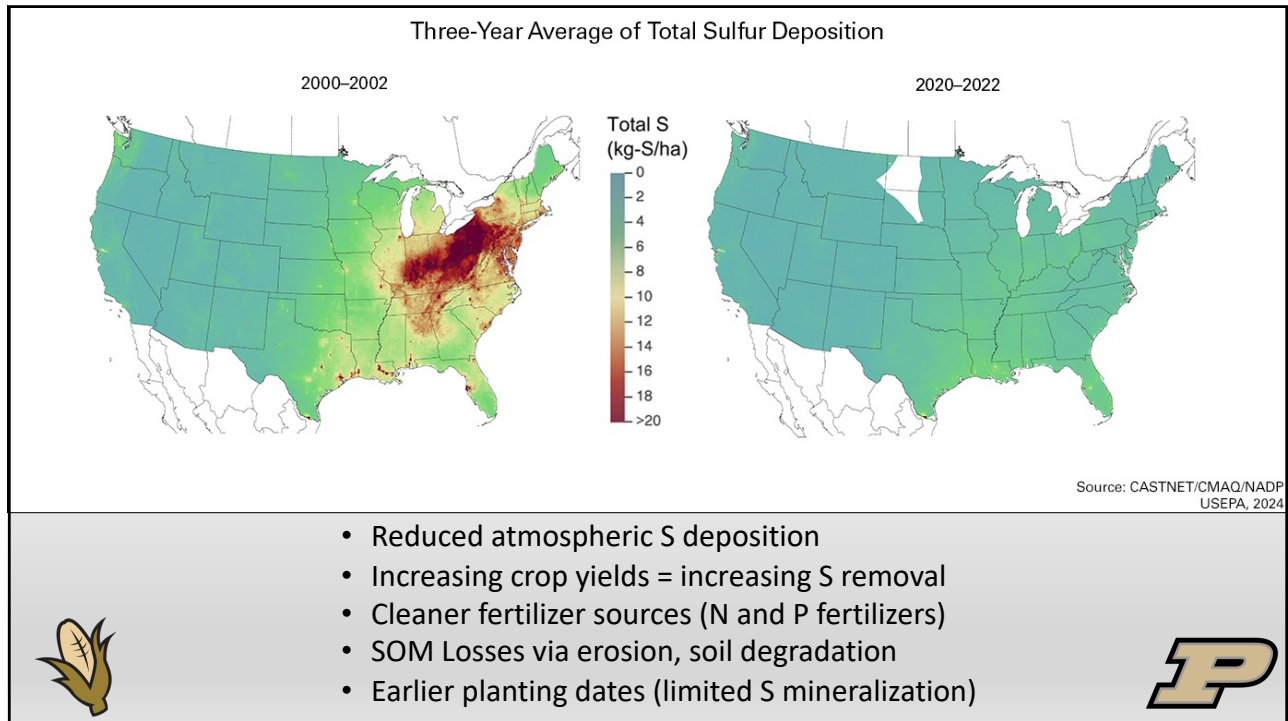
1

Why are N and S important for Corn Production?

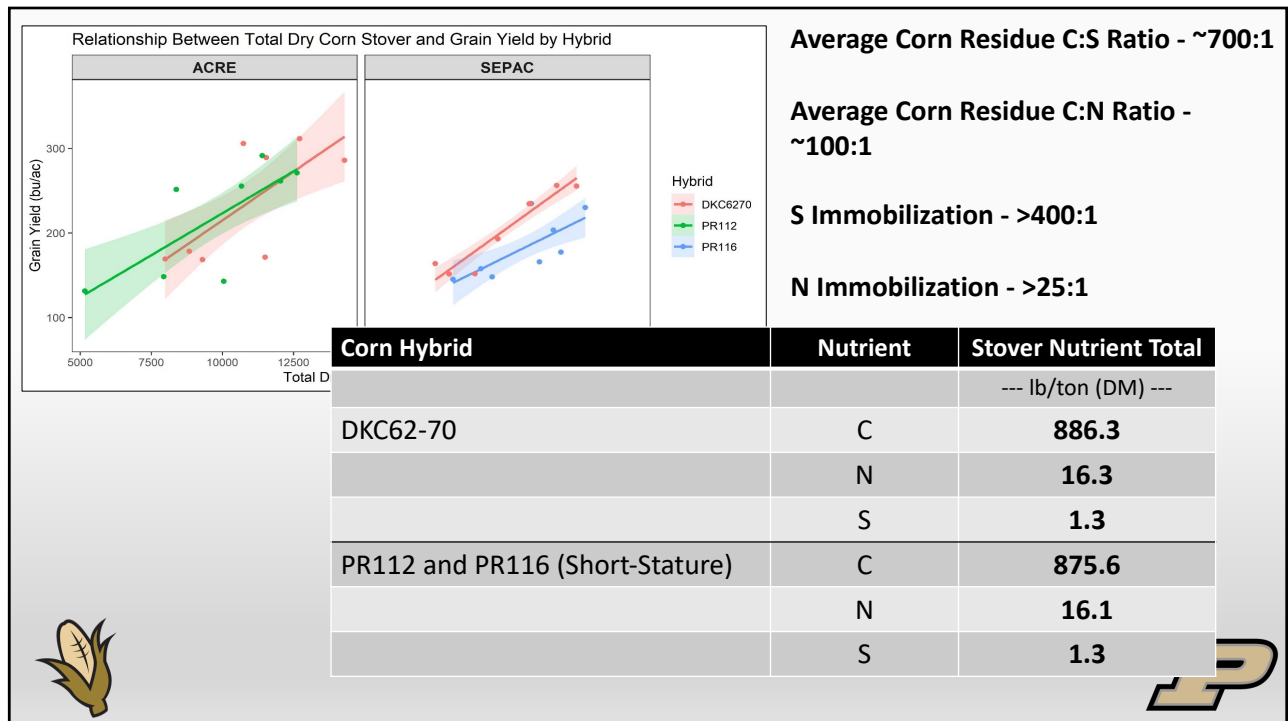
- Protein and amino acid production
- Chlorophyll production – necessary for photosynthesis
- Sulfur Assimilation (*Nitrogen*)
- Nitrogen Metabolism (*Sulfur*)




2




3




4




**+20 bu/ac
w/ AMS
(2025)**



**+14 bu/ac
w/ ATS
(2024)**



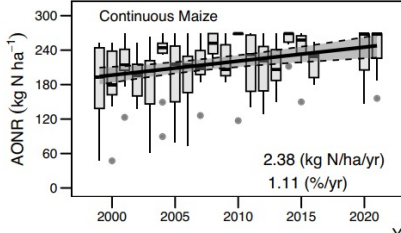
Systems which often require higher N (cereal cover crops, corn-corn rotation) due to immobilization also can show increased incidence of sulfur deficiencies



5

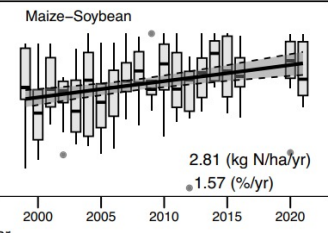
Agronomic (AONR) and Economic (EONR) and Sulfur Dependency have been increasing over time for Midwest Corn Production

(A) Agronomic Optimum N Rate



Continuous Maize

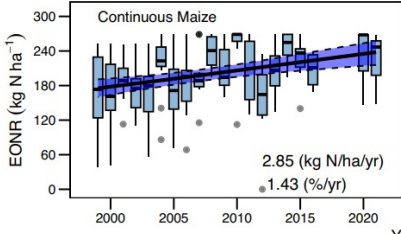
2.38 (kg N/ha/yr)
1.11 (%/yr)



Maize-Soybean

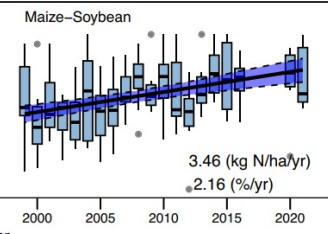
2.81 (kg N/ha/yr)
1.57 (%/yr)

(B) Economic Optimum N Rate



Continuous Maize



2.85 (kg N/ha/yr)
1.43 (%/yr)



Maize-Soybean

3.46 (kg N/ha/yr)
2.16 (%/yr)

Baum et al, 2025.
The optimum nitrogen fertilizer rate for maize in the US Midwest is increasing. Nat. Comm. 16:404

6

3

Corn Relative Yield Response compared to R1 Ear Leaf S Concentration (%)

Crop	Stage	Plant part	Number or area per sample	Values associated with S deficiency	
				%S	N:S
Corn	≤12 inches	Whole plant beginning ½ inch above soil	20-30	<0.18	>16:1
	>12 inches to tasseling	Youngest collared leaf or earleaf at tasseling	15-25		



© D.J. Quinn, Purdue University

Camberato et al., 2022. Sulfur deficiency in corn, soybean, alfalfa, and wheat. Bull. AY-379-W. Purdue Univ. Ext.
<https://www.extension.purdue.edu/extmedia/AY/AY-379-W.pdf>



7

N and S Connection

- Nitrogen and Sulfur are co-required for building proteins, amino acids and chlorophyll production.
 - Imbalance in one limits the effective use of the other (Kruse et al., 2007)
 - Interdependence in reduction pathways and protein synthesis (Janzen and Bettany, 1984)
 - Proteins require proper N:S ratios in plants (Dijkshoorn and Van Wijk, 1967)
- Sulfur deficiency can...
 - Reduce crop N-use efficiency
 - Reduce N uptake, transport, and metabolism
 - Reduce nitrate reductase activity
 - Reduce protein formation
 - Reduces N-fixation in legumes (e.g., soybean S deficiencies)



8

As N Fertilizer Rate Increases, So Does Plant N:S Ratio

Crop	Stage	Plant part	Number or area per sample	Values associated with S deficiency	
				%S	N:S
Corn	≤12 inches	Whole plant beginning ½ inch above soil	20-30	<0.18	>16:1
	>12 inches to tasseling	Youngest collared leaf or earleaf at tasseling	15-25		



Camberato et al., 2022. Sulfur deficiency in corn, soybean, alfalfa, and wheat. Bull. AY-379-W. Purdue Univ. Ext. <https://www.extension.purdue.edu/extmedia/AY/AY-379-W.pdf>



9

Presence of Severe S Deficiency at High N Fertilizer Rates – Michigan, 2024 (K. Steinke)



0 N



120 N



240 N



Slide and Images by A. Blaylock - Nutrien



10

Corn Response to N Fertilizer Rate w/ and w/o the Inclusion of S (Preliminary Results)



11



Pinney Purdue
Agricultural Center
(PPAC), Wanatah, IN

Agronomy Center for
Research and Education
(ACRE), West Lafayette, IN

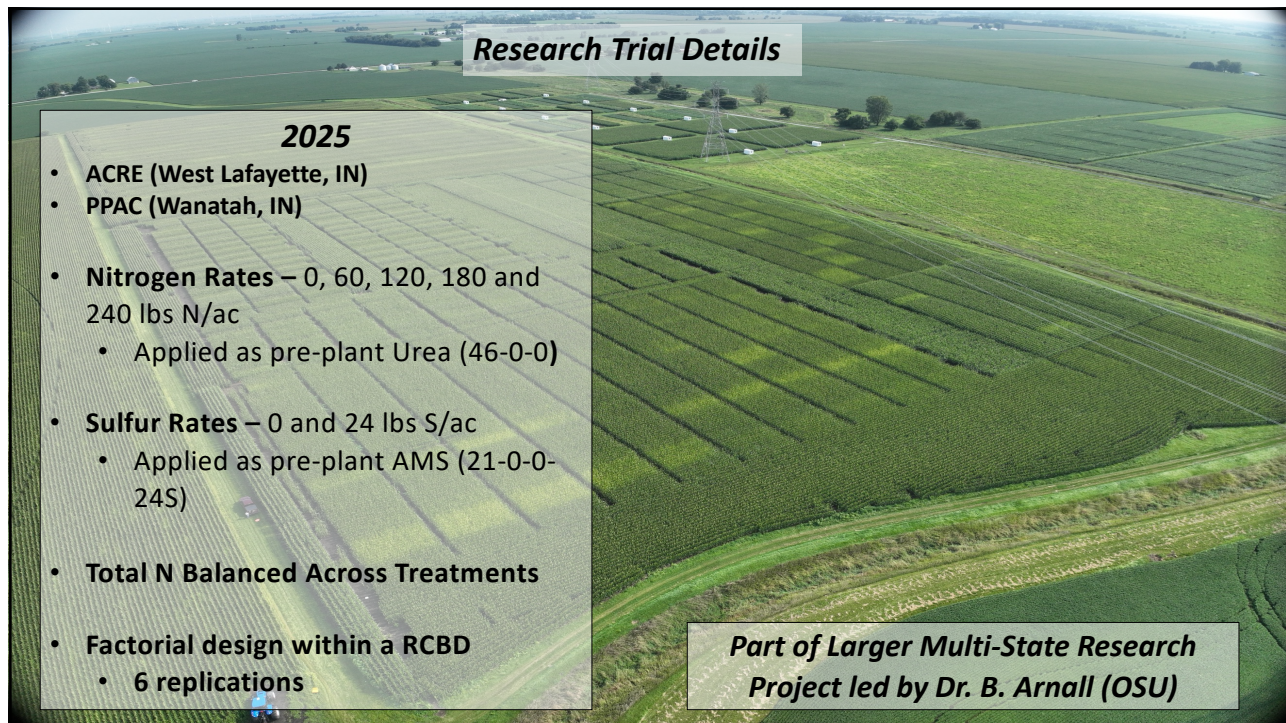
***NxS Interaction Research -
2025***



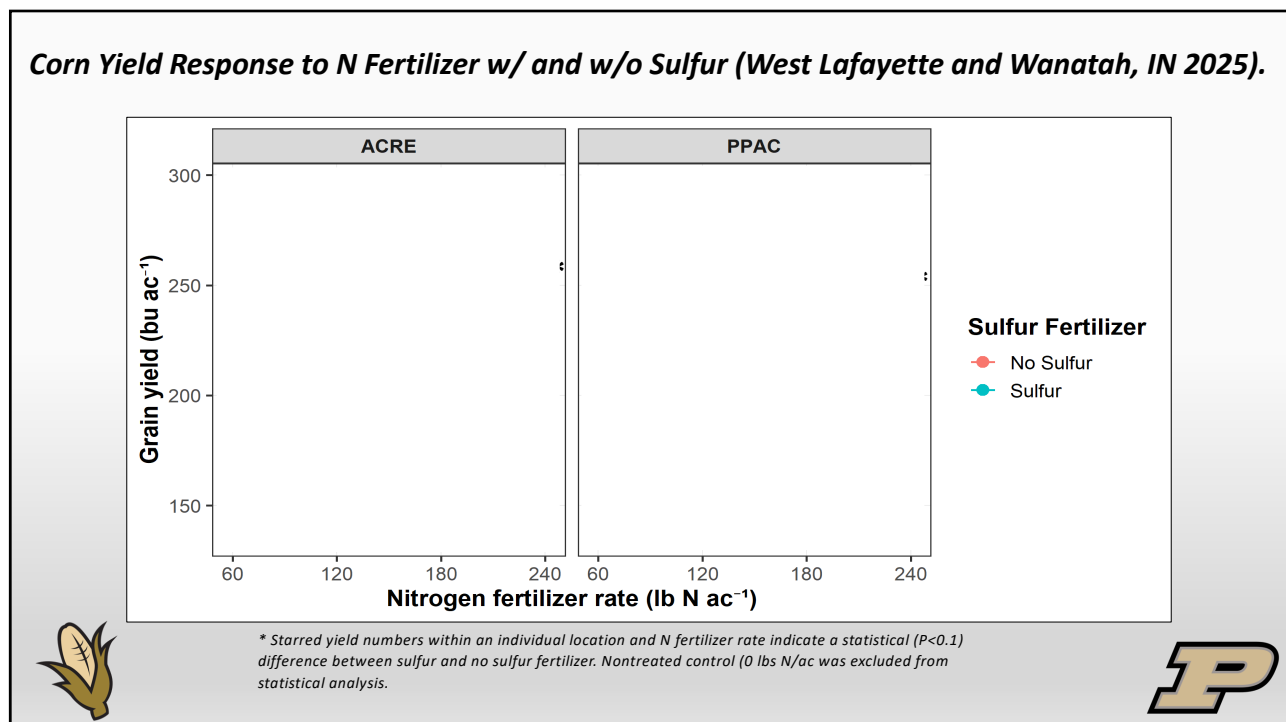
12



12

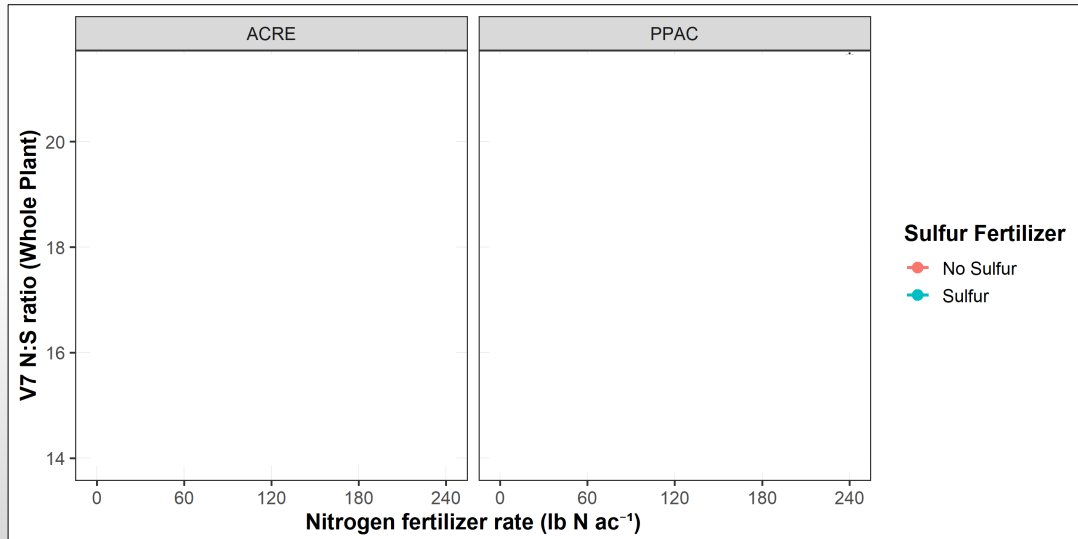


13



14

Corn V7 Whole Plant N:S Ratio Response to N Fertilizer w/ and w/o Sulfur (West Lafayette and Wanatah, IN 2025).

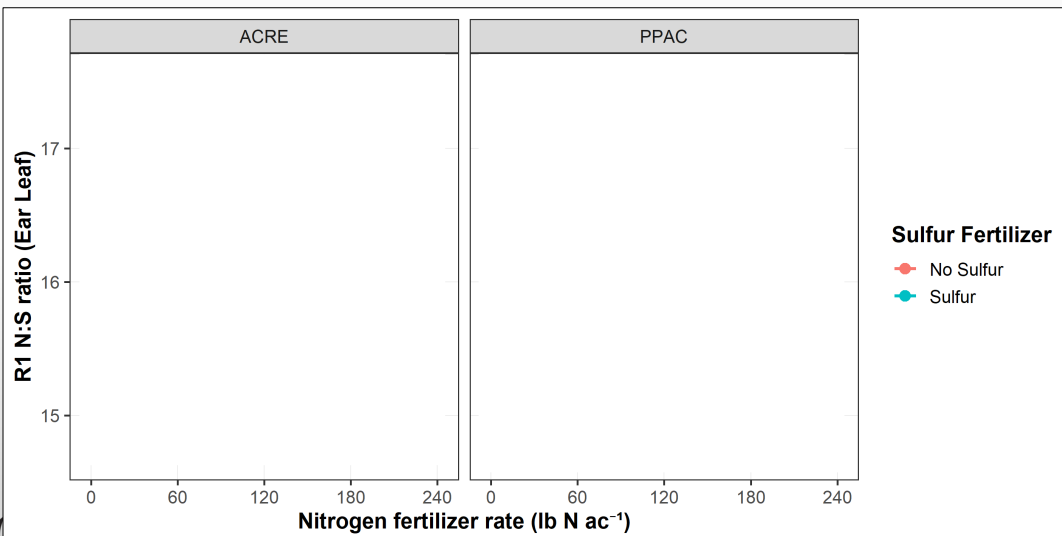


* Starred points within an individual location and N fertilizer rate indicate a statistical ($P < 0.1$) difference between sulfur and no sulfur fertilizer. Nontreated control (0 lbs N/ac) was excluded from statistical analysis.



15

Corn R1 Ear Leaf N:S Ratio Response to N Fertilizer w/ and w/o Sulfur (West Lafayette and Wanatah, IN 2025).

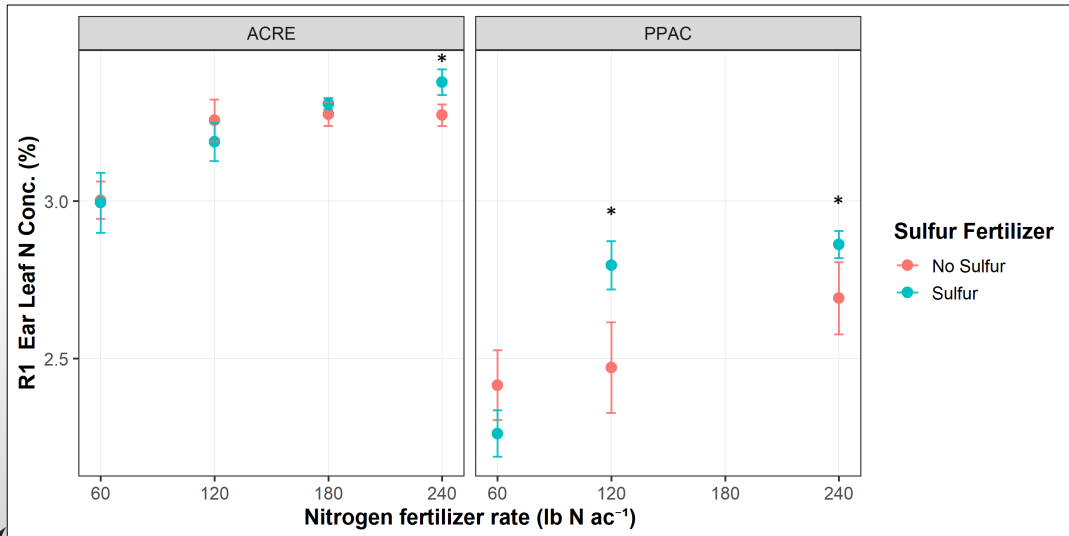


* Starred points within an individual location and N fertilizer rate indicate a statistical ($P < 0.1$) difference between sulfur and no sulfur fertilizer. Nontreated control (0 lbs N/ac) was excluded from statistical analysis.



16

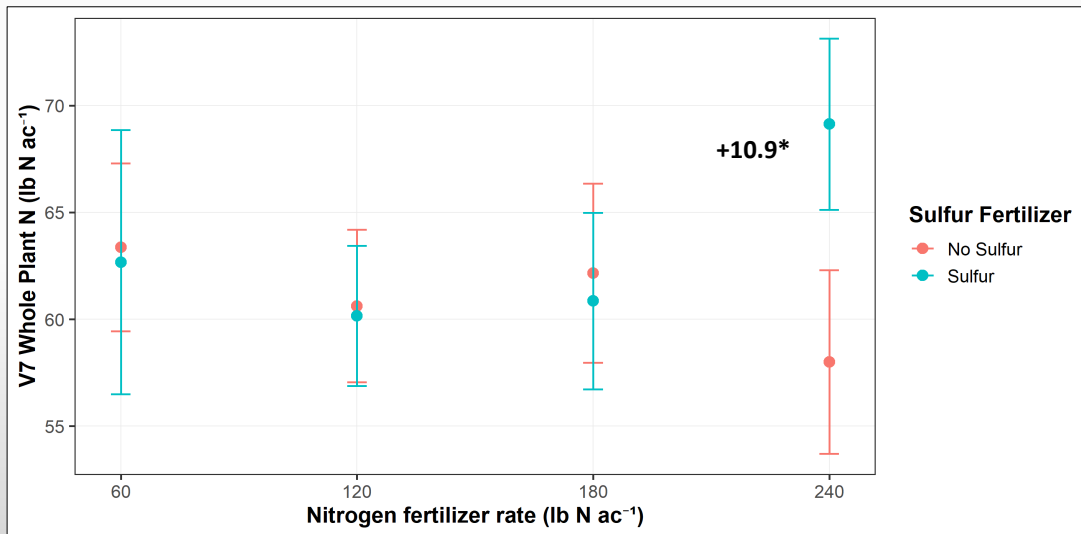
Corn Ear Leaf N Concentration (%) in Response to N Fertilizer w/ and w/o Sulfur (West Lafayette and Wanatah, IN 2025).



* Starred points within an individual location and N fertilizer rate indicate a statistical ($P < 0.1$) difference between sulfur and no sulfur fertilizer. Nontreated control (0 lbs N/ac) was excluded from statistical analysis.

17

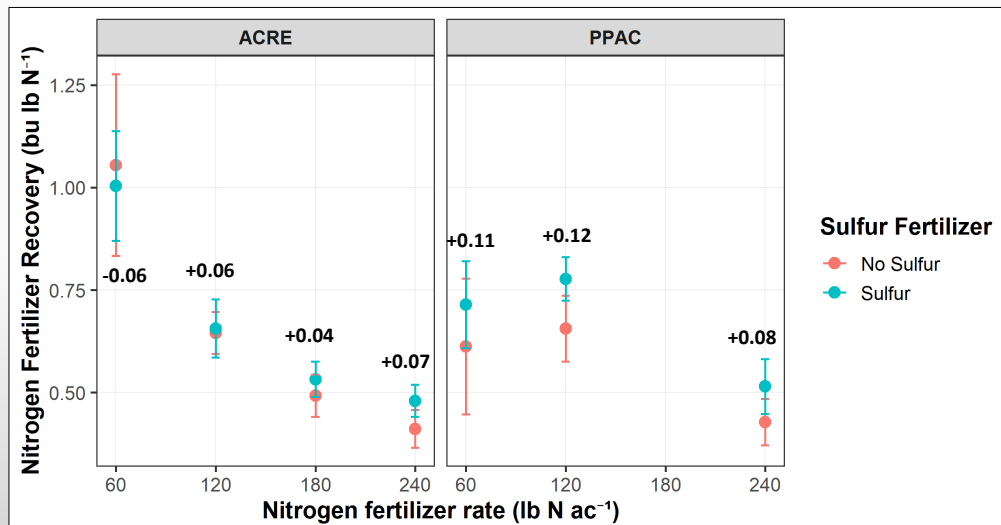
Corn V7 Whole Plant Nitrogen Uptake (lbs N/ac) in Response to N Fertilizer w/ and w/o Sulfur (West Lafayette and Wanatah, IN 2025).



* Starred points within an individual location and N fertilizer rate indicate a statistical ($P < 0.1$) difference between sulfur and no sulfur fertilizer. Nontreated control (0 lbs N/ac) was excluded from statistical analysis.

18

Corn Nitrogen Fertilizer Recovery (bu/lb of N) in Response to N Fertilizer w/ and w/o Sulfur (West Lafayette and Wanatah, IN 2025).



* Starred points within an individual location and N fertilizer rate indicate a statistical ($P < 0.1$) difference between sulfur and no sulfur fertilizer. Nontreated control (0 lbs N/ac) was excluded from statistical analysis.

19

Preliminary Conclusions and Take Home Points (NxS Research)

- Incidence of Sulfur Deficiencies and Applied N Fertilizer Rates in Corn Continue to Increase
- N and S have a strong interdependence in the plant
 - Imbalance of one limits the other
- Plant tissue (V7 whole plant, R1 ear leaf) N:S ratio increases as N fertilizer rate increases
 - Sulfur fertilizer inclusion reduced tissue N:S ratio at higher applied N fertilizer rates.
- Sulfur inclusion increased corn V7 whole plant N uptake and R1 ear leaf N concentration at high applied N fertilizer rates.
- Preliminary yield results observed highest S fertilizer yield responses (+16 – 19 bu/ac) at the highest N fertilizer rates applied (240 lbs N/ac)
 - As N fertilizer rate decreased, so did S fertilizer response
- Research trial will be repeated in 2026 and 2027. Will also be combined with a larger multi-state effort for broader inferences.

20

Future Research Considerations

- Higher N Fertilizer Requirements May Require Higher S Fertilizer Requirements
 - Do S fertilizer requirements need to match N fertilizer rate applied?
- Need to include additional S fertilizer rates across NxS trials
 - Does a higher S rate improve yield response at higher N fertilizer rates even more?
- Future of N rate recommendation research
 - Are some of the results lacking due to the exclusion of S fertilizer?
 - Sensor detection and calibration?



21

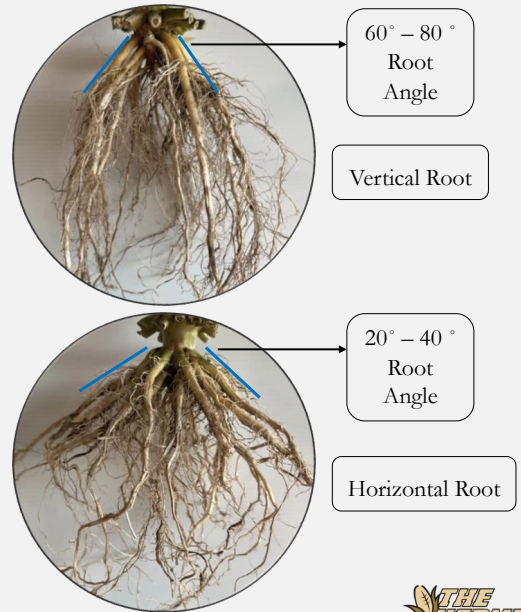
Corn Hybrid Root Architecture x Nutrient Placement Research (Preliminary Results)



22

Does Hybrid Selection Matter for Fertilizer Application Type?

- Corn hybrids differ in root system architecture (**Foxhoven, 2022; Beck's Root Reveal™ Research**)
 - Smaller-rooted hybrids achieved higher yields when P and K were banded directly in the root zone (**Foxhoven, 2022**)






23

2024 - 2025

- ACRE (West Lafayette, IN)
- PPAC (Wanatah, IN)
- **Fertilizer Source and Rate:** SuperU (46-0-0) + MESZ (12-40-0-10S-1Zn). Balanced for 200 lbs N/ac and 20 lbs S/ac.
- **Fertilizer Placement(s):** Surface broadcast and Banded (4 – 6 inch from seed). Both applied at planting.
- **Hybrid(s):**
 - Beck's 6184 (vertical)
 - Beck's 6414 (vertical)
 - Beck's 6152 (horizontal)
 - Beck's 6274 (horizontal)

Research Trial Details

24

Research Trial Details – cont.

➤ Data collection



Whole-plant biomass at V5, V7, V8, and R1

Roots at V5, V7, and R1



Grain yield at R6



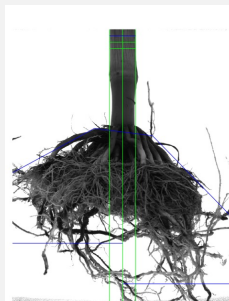
25

Research Trial Details – cont.

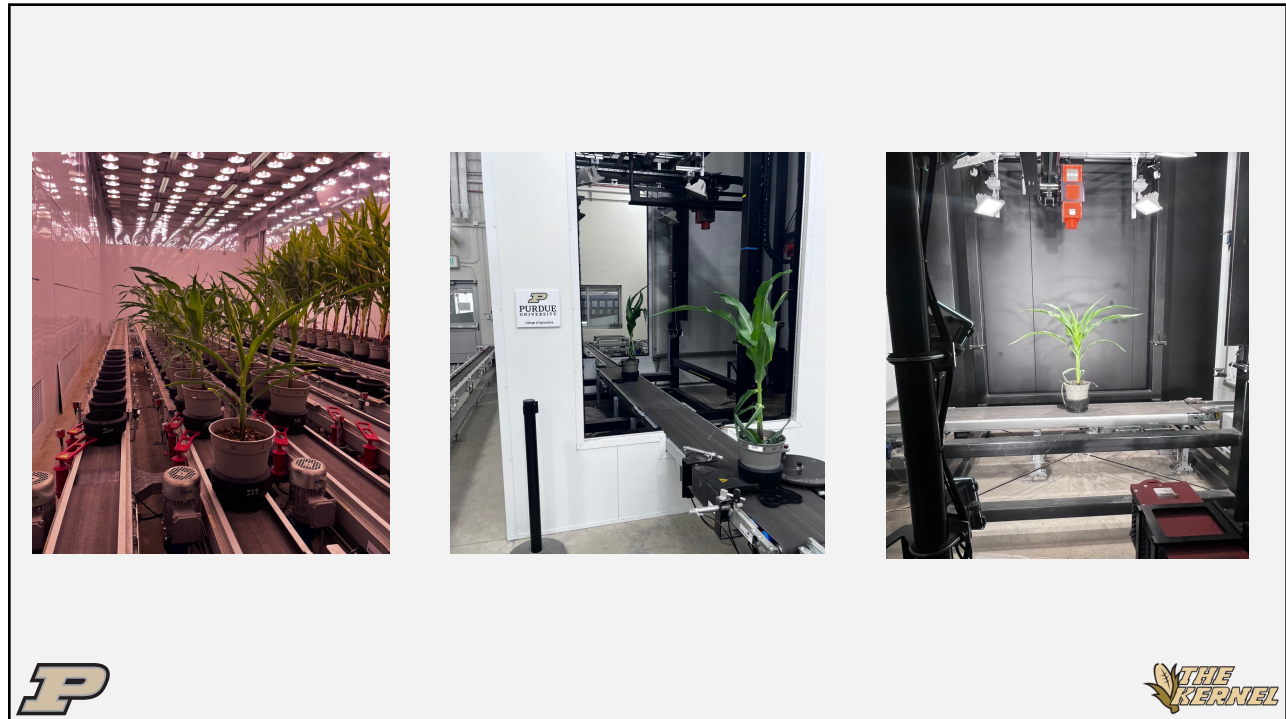
➤ Root traits measurement

Corn Root Imaging Platform (CROP)

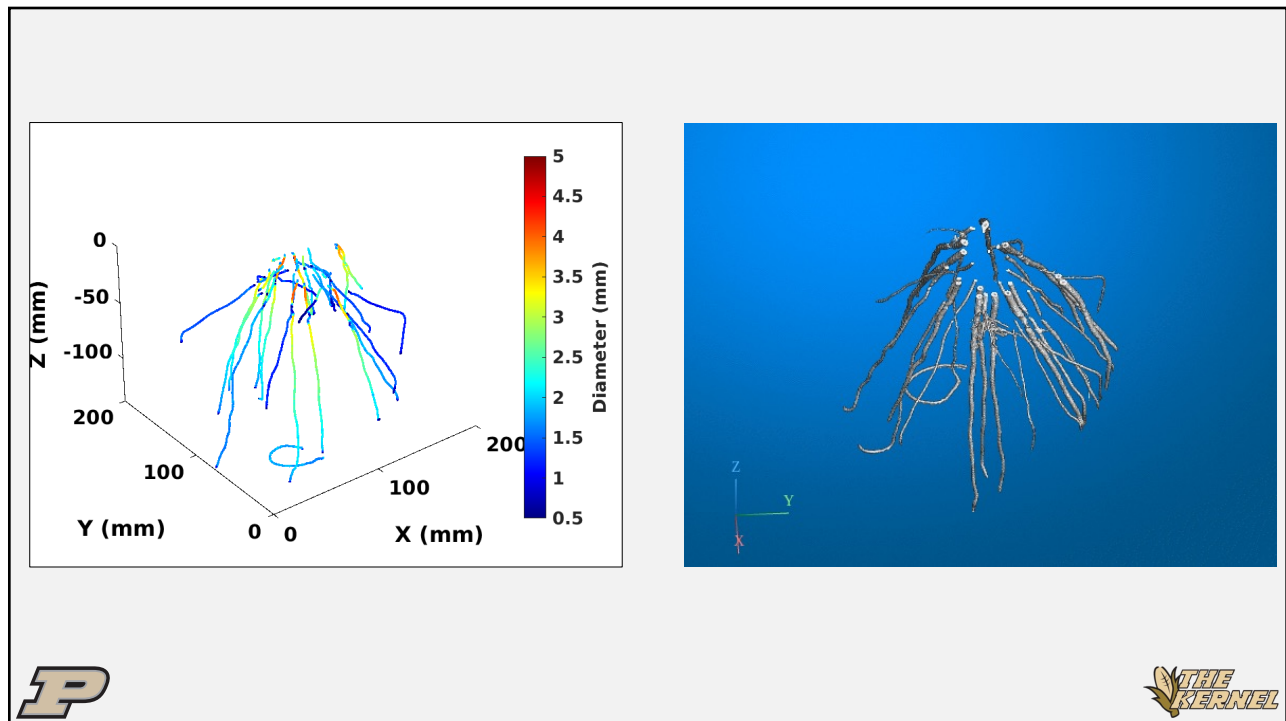
Root Surface Area Root Angle



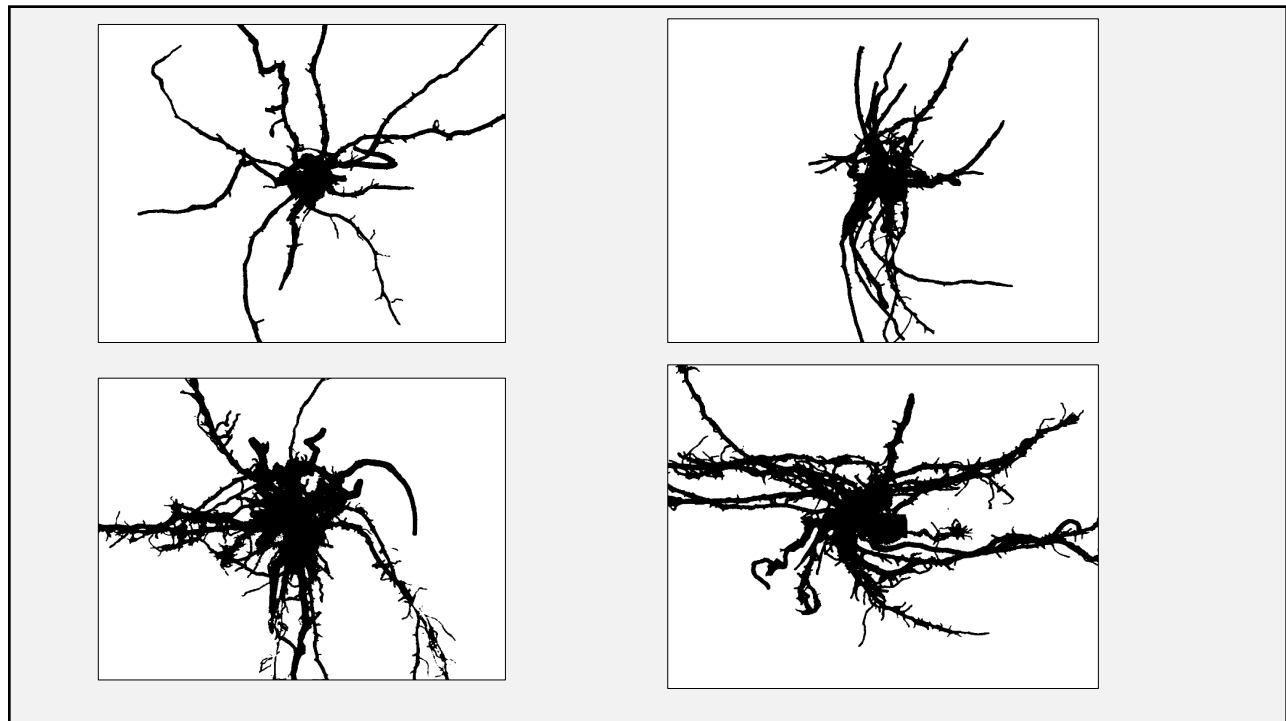
26



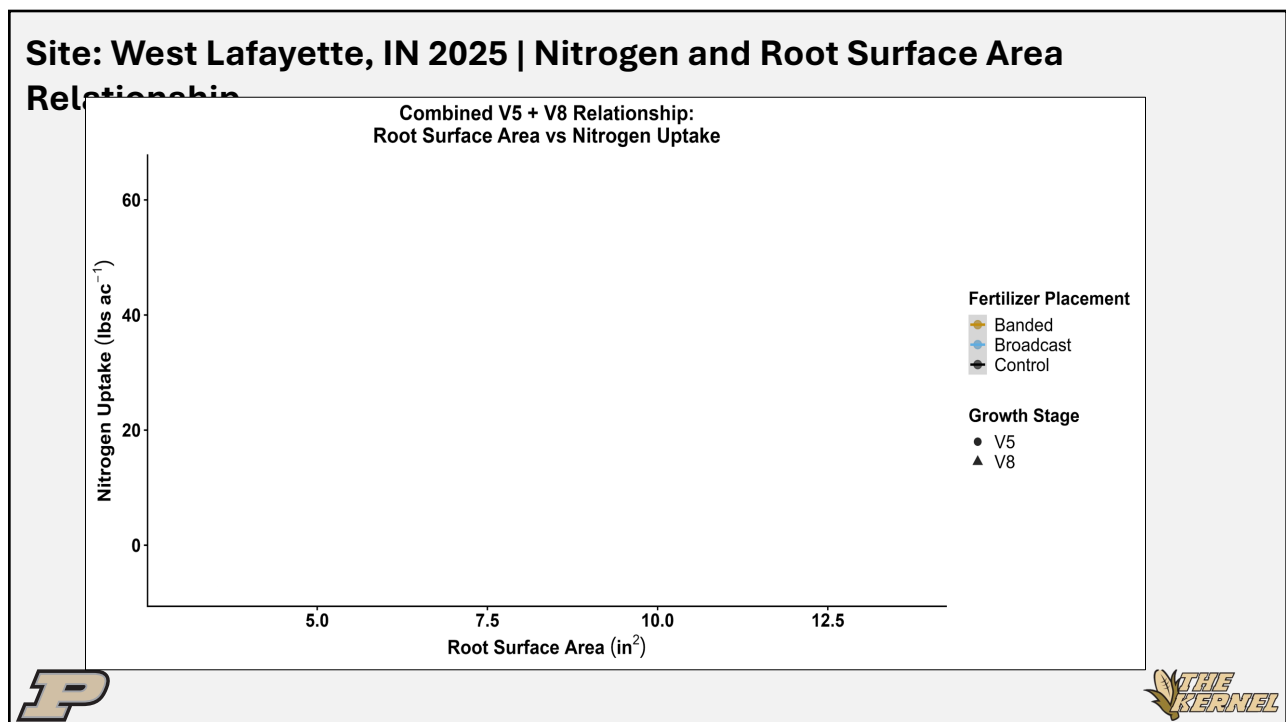
27



28

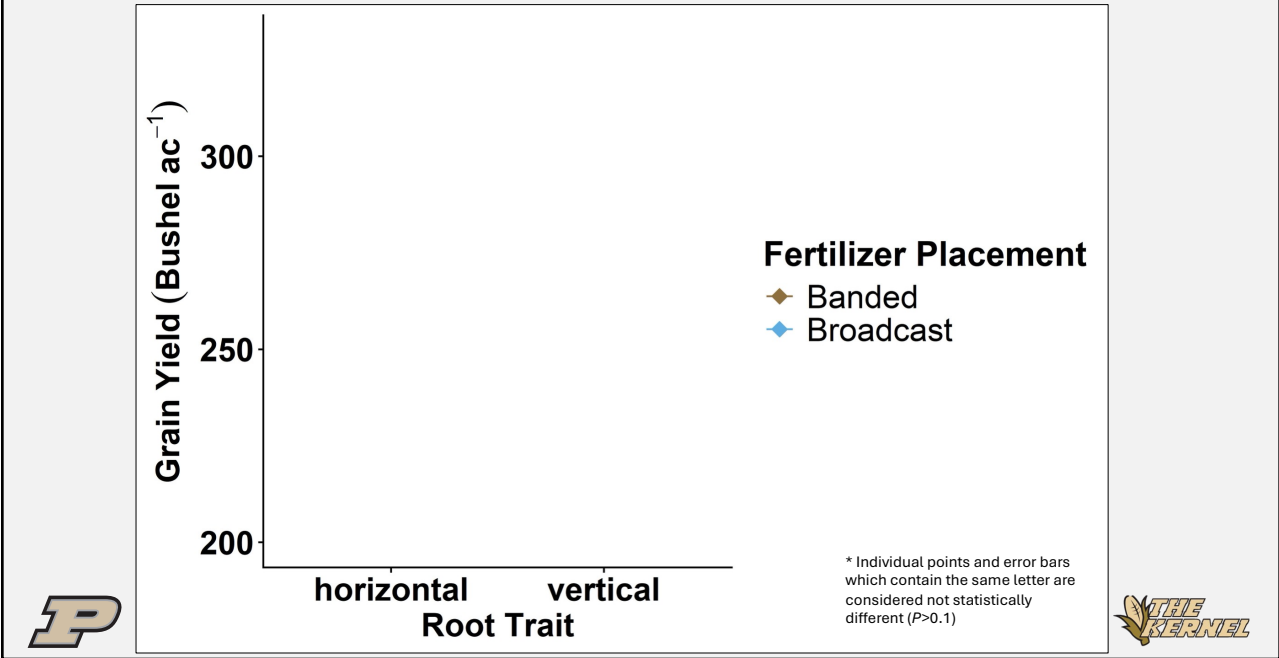


29



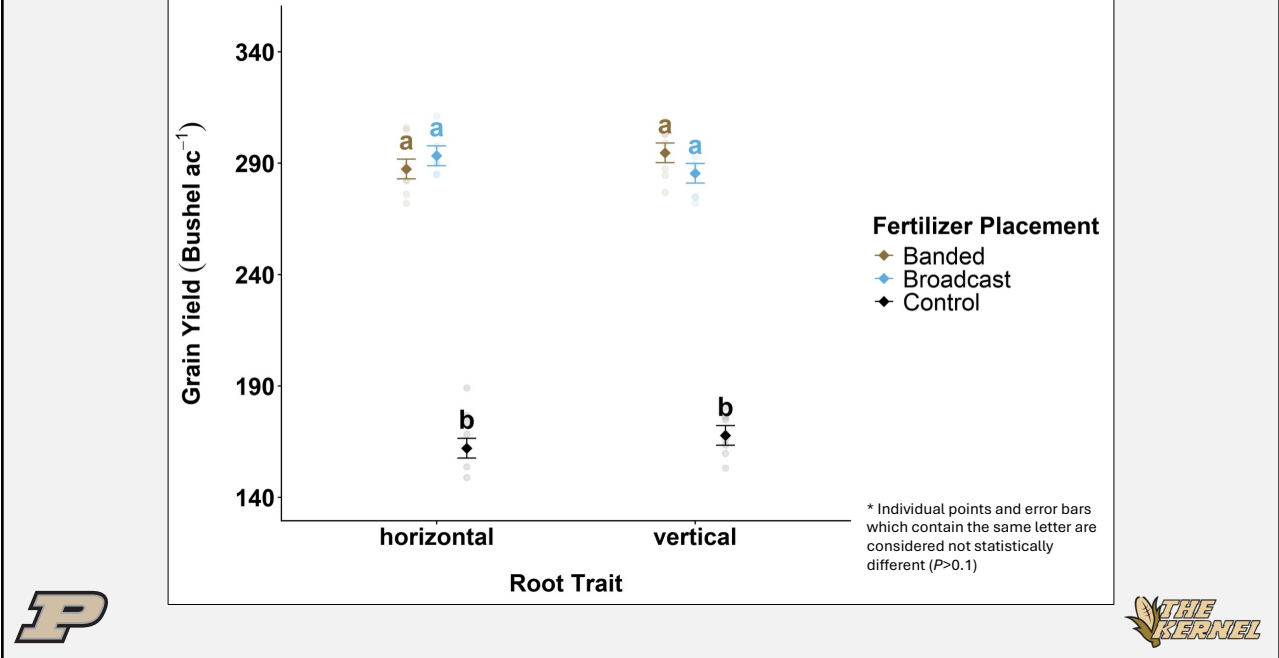
30

Site: West Lafayette, IN 2024

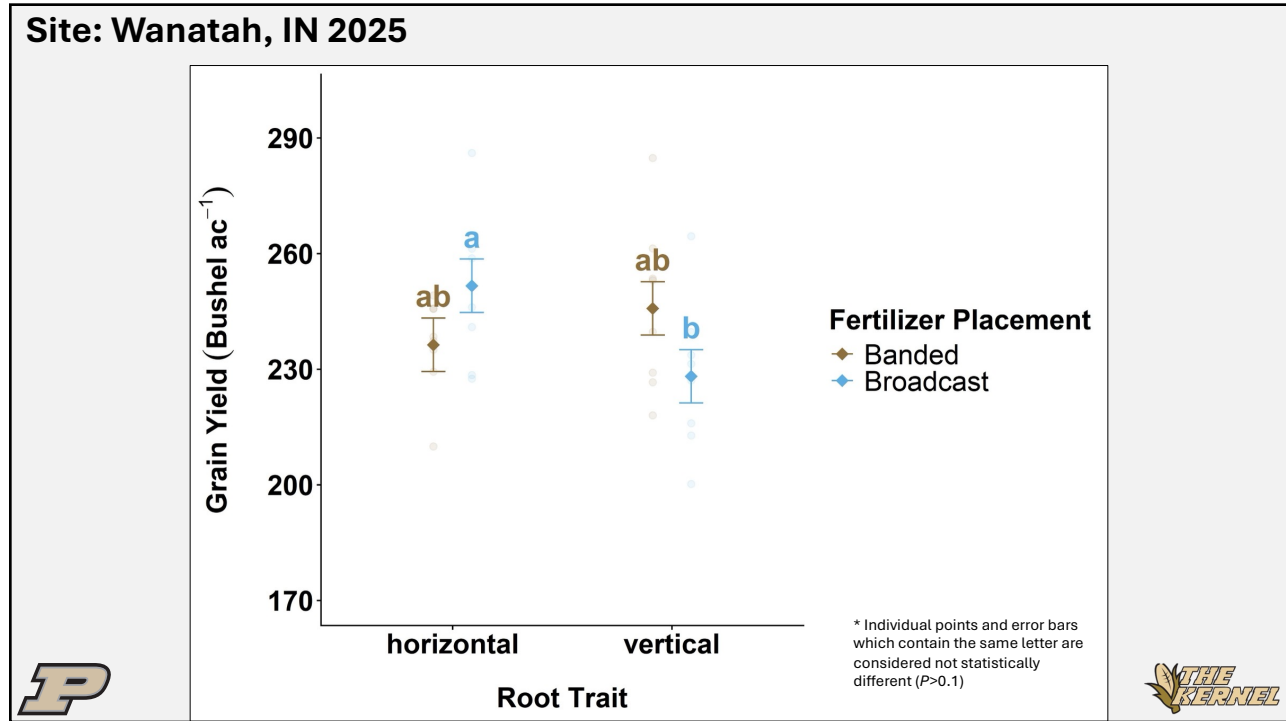


31

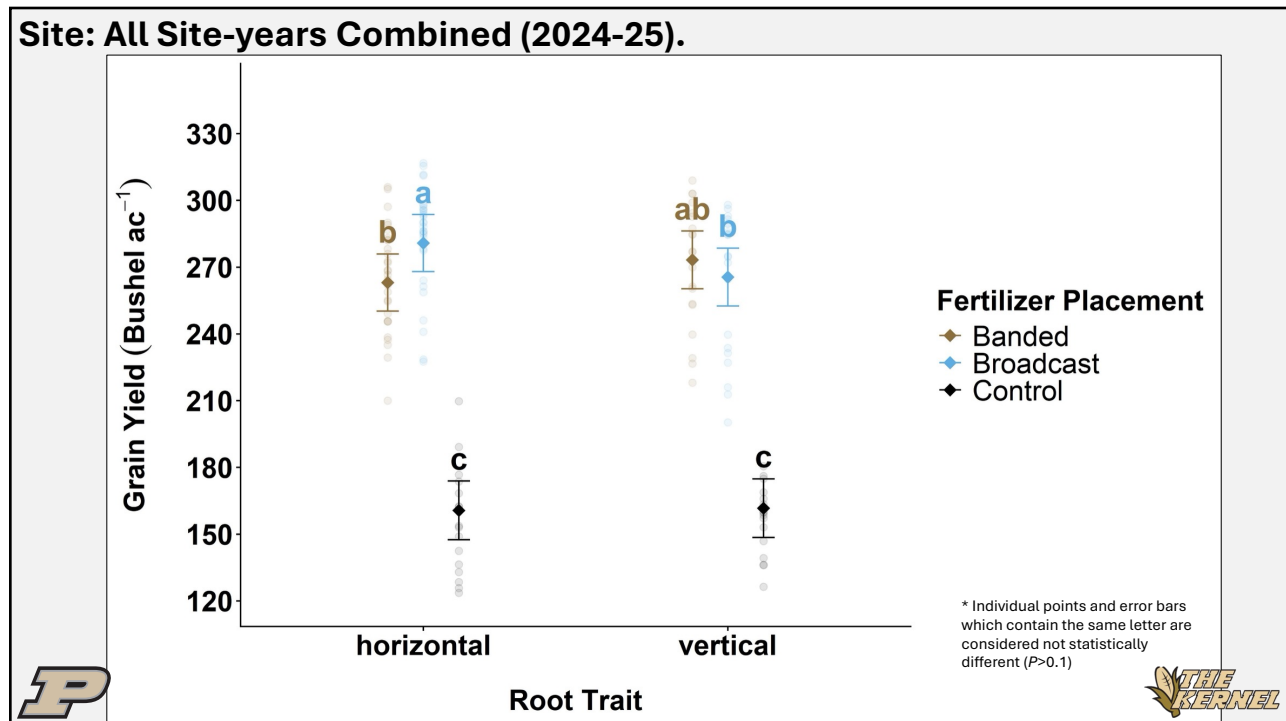
Site: West Lafayette, IN 2025



32



33



34

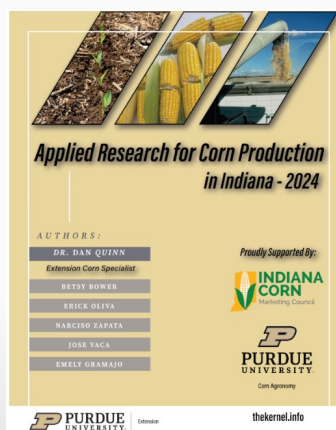
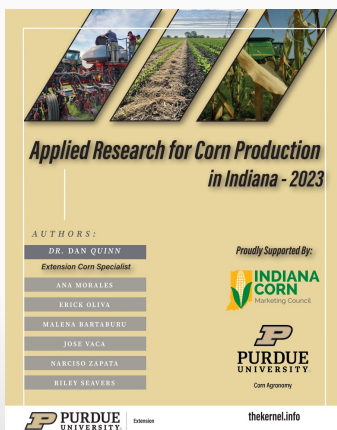
Preliminary Conclusions and Take Home Points (Hybrid Root x Fertilizer Placement)

- Not all corn hybrids are created equal
- As hybrid root surface area increased, early-season whole plant (V5 and V8) nutrient uptake also increased.
- In 2 of 3 site-years, hybrid root angle classification (vertical vs. horizontal) influenced response to fertilizer application method.
- Preliminary results suggest hybrid decision and placement may need to consider fertilizer application method (more data still required).
- Research trial will be repeated in 2026 and 2027. More data is required.



35

Research Books and Newsletter



Applied Research for Corn Production in Indiana – Annual Research Book.



<https://ag.purdue.edu/departments/agry/faculty-pages/the-kernel/>



Weekly Indiana Corn Progress and Research Update.



36

Questions?

Daniel J. Quinn, Ph.D.

Assistant Professor of Agronomy
Extension Corn Specialist
Purdue University

Email: diquinn@purdue.edu

Ph: 765-494-5314

Web: <https://thekernel.info>

Twitter/X: @PurdueCorn

Podcast: Purdue Crop Chat (Hoosier
Ag Today)



PURDUE
UNIVERSITY

Corn Agronomy



BECK'S

Nutrien



**INDIANA
CORN**
Marketing Council



© D.J. Quinn, Purdue University

37

