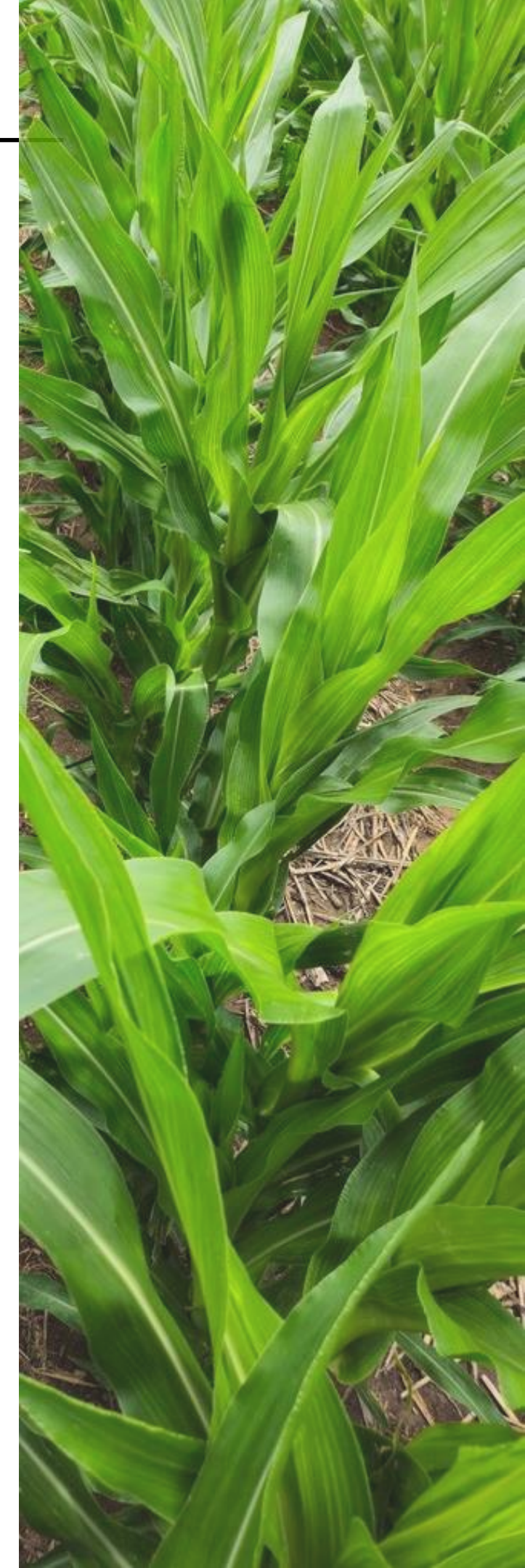




Improving Soil Test Phosphorus Recommendations for Corn Production in Colorado

An Investigation of Rate, Source, and Timing

DR. JOSHUA MOTT – VIRGINIA TECH
DR. GRACE MINER – USDA-ARS



AGRICULTURAL PRODUCTION SYSTEMS THAT BETTER CYCLE RESOURCES AND PROMOTE DIVERSITY OF BENEFITS

Key projects: Precision Management (Input use efficiencies), Yield and Quality outcomes, Applied pest management (wheat stem sawfly), Diversification/Conservation,

1 Nutrient Management/Precision Management

Precision Management (on-station, on-farm)
Nutrient Response Trials (P, Zn, N)

2 Yield and Quality Outcomes

Wheat yield and protein

3 Wheat Stem Sawfly - applied pest management

Integrated Pest Management of WSS involves a multi-faceted approach including **Biological Control, Harvest Method, Management, and Plant Breeding.**

4 Diversification/Conservation

National, Coordinated assessment of emerging 'dual-use' perennial



USDA-ARS Kernza® Initiative

Common Measurements and Standardized Protocols

Description	Method	Sample handling
Soil Measurements		
pH	1:1 soil to water mass ratio	Dried at 40 °C
Buffer pH	Shoemaker, McLean & Pratt or Sikora	Dried at 40 °C
Electrical Conductivity	1:1 soil to water mass ratio	Dried at 40 °C
Extractable Phosphorus	Olsen & Mehlich-3 (all sites) + Bray (non-calcareous sites)	Dried at 40 °C
Exchangeable Ca, K, Mg, Na, and Mn	NH ₄ OAc (or Mehlich-3) extract, ICP-OES	Dried at 40 °C
Nitrate-N + Ammonium-N	2M KCl extract	Dried at 40 °C or Air dried
DTPA-micronutrients	DTPA/ICP	Dried at 40 °C
Total/Organic/Inorganic carbon and total nitrogen	Ramped combustion	Dried at 40 °C
Bulk density	Core method or ESM	Dried at 40 °C
Forage Measurements		
Biomass Yield	Standardized Quadrat	Dried at 60 °C
Protein Analysis	Combustion	
Fiber (NDF, ADF, ADL)	Sequential fibers	Ground to 1 mm
Invitro digestibility – 30 hours		
Forage Fragility	Experimental	
Grain Measurements		
Grain Yield	Standardized Quadrat	Dried at 60°C
Protein Analysis	Combustion and NIR	
Mineral Nutrients	ICP-OES	



Network Grafting





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FRST Fertilizer Recommendation Support Tool

Home Tool Manual Feedback Funding Privacy Register Login

Soil Nutrient P

Crop Corn

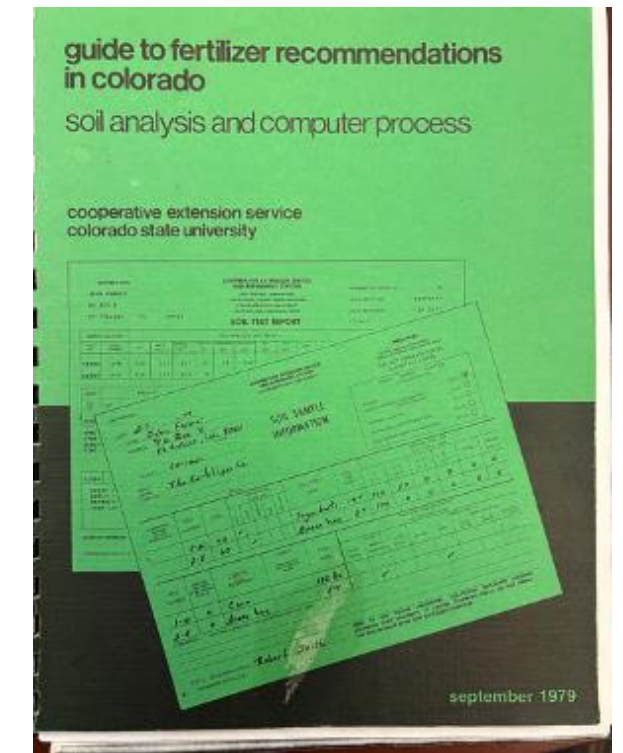
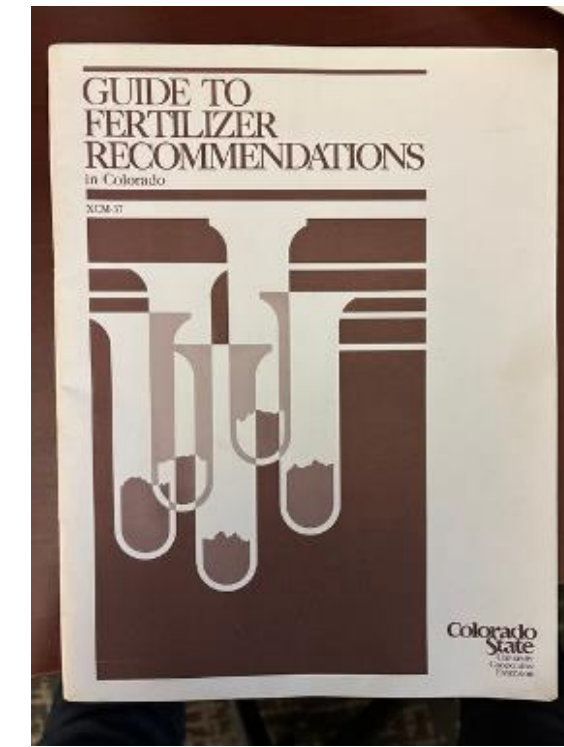
Grain Yield Range (bu/ac)
From 30 to 330

States/Territories

Clear States and Territories

- Alabama
- Arkansas
- Delaware
- Florida
- Minnesota
- Mississippi
- Missouri
- Nebraska

Historical Timeline: Colorado P Recs



1979 Parviz N. Soltanpour, Albert E. Ludwick, John O. Reuss

1991 R.H. Follet, P.N. Soltanpour, D.G. Westfall, J. R. Self

2024 Fact Sheet No. 0.538. J.G. Davis and D.G. Westfall

Phosphorus Recommendations

Phosphorus (P) soil test ppm		Fertilizer phosphorus lbs/A P_2O_5
0-3	low	40
4-7	medium	20
>7	high	0

Table 5b. Phosphorus Recommendations

Phosphorus (P) soil test ppm		Fertilizer phosphorus lbs/A P_2O_5
0-3	low	40
4-7	medium	20
> 7	high	0

Table 4: Suggested phosphorus rates for band and broadcast applications to irrigated and dryland corn calculated from the algorithm.

ppm P in soil		Relative level	Fertilizer rate, lb P_2O_5 /A	
AB-DTPA	NaHCO ₃		Banded	Broadcast
0 - 3	0 - 6	low	40	80
4 - 7	7 - 14	medium	20	40
8 - 11	15 - 22	high	0	0
> 11	> 22	very high	0	0

For more precise rates, use the algorithm in the text relating to the soil test method.

Historical Timeline: Colorado P Recs

2025

PPM P IN SOIL		RELATIVE LEVEL	FERTILIZER RATE (LB P ₂ O ₅ /A)	
MEHLICH-3	NAHCO ₃ (OLSEN)		BANDED	BROADCAST
0 – 10	0 – 6	Low	40	80
11 – 22	7 – 14	Medium	20	40
23 – 35	15 – 22	High	0	0
> 35	> 22	Very High	0	0

“As I think back as to what happened many years ago regarding the P recommendations in corn, they were based upon those put out by the University of Nebraska. I cannot recall any phosphorus fertility work conducted in Colorado on corn.”
- Dr. Dwayne Westfall

SITE INFORMATION

- ARDEC – Colorado State University
- 15 inches annual precipitation
- Irrigated trial
- Fort Collins Loam
- Well drained, decent fertility, alkaline pH

EXPERIMENTAL DESIGN

- RCB; 4 blocks
- 2x2x4 factorial + min 2 checks
- Timing (2) x Source (2) x Rate (4)
- 18 trts, 72 plots

Fig 1. Mean yields and soil test values for 2024 and 2025 Phosphorus trials on corn in Fort Collins, CO. Numbers in parentheses represent standard deviation.

Year	Yield (bu acre ⁻¹)	SOM (%)	Olsen-P (mg kg ⁻¹)	pH
2024	197 (19)	2.7 (0.1)	3.9 (1.3)	8.23 (0.05)
2025	266 (21)	2.1 (0.1)	13.2 (2.3)	7.95 (0.06)

Unpublished soil test data from 2024 and 2025 trials.



EXPERIMENTAL DESIGN

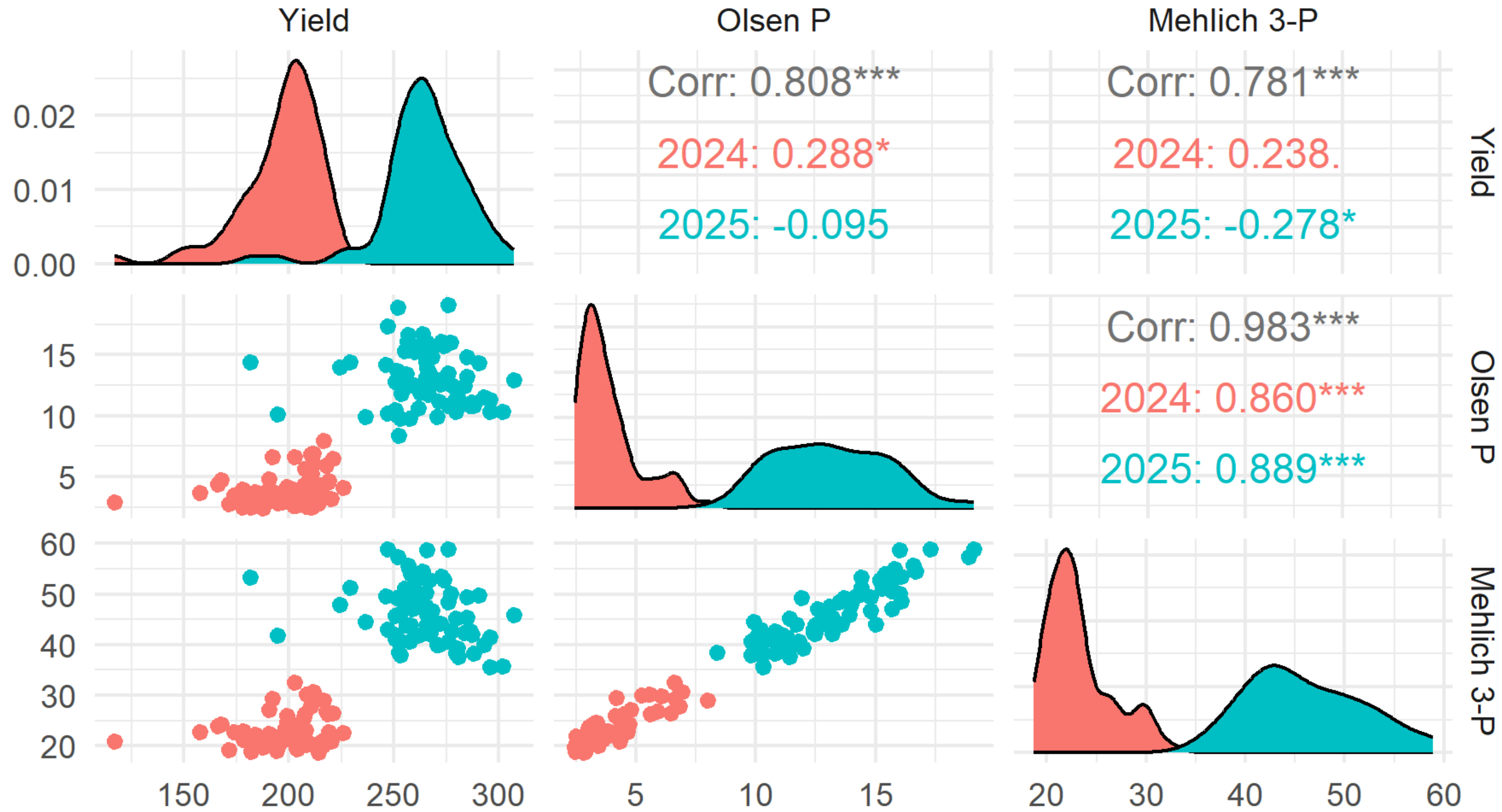
- **Baseline Soil Test P**
 - 0–6" composite sample (plot level)
- **Fertilizer Treatments:**
 - DAP (18–46–0) and TSP (0–46–0)
 - (4 rates: 14.6, 29.3, 43.9, 58.6 kg P ha) and 1 to 2 0–P checks per block (≥ 4 replications)
 - Broadcast application
- **Application Timing Treatments:**
 - Fall and Spring (Pre-plant)
 - All other nutrients applied to sufficiency at planting.
- **Nitrogen Losses:**
 - Deep core Soil N samples (Fall and Spring)
 - Samples only collected in control and fall applied plots

RESULTS

Fig 1. Mean yields and soil test values for 2024 and 2025 Phosphorus trials on corn in Fort Collins, CO. Numbers in parentheses represent standard deviation.

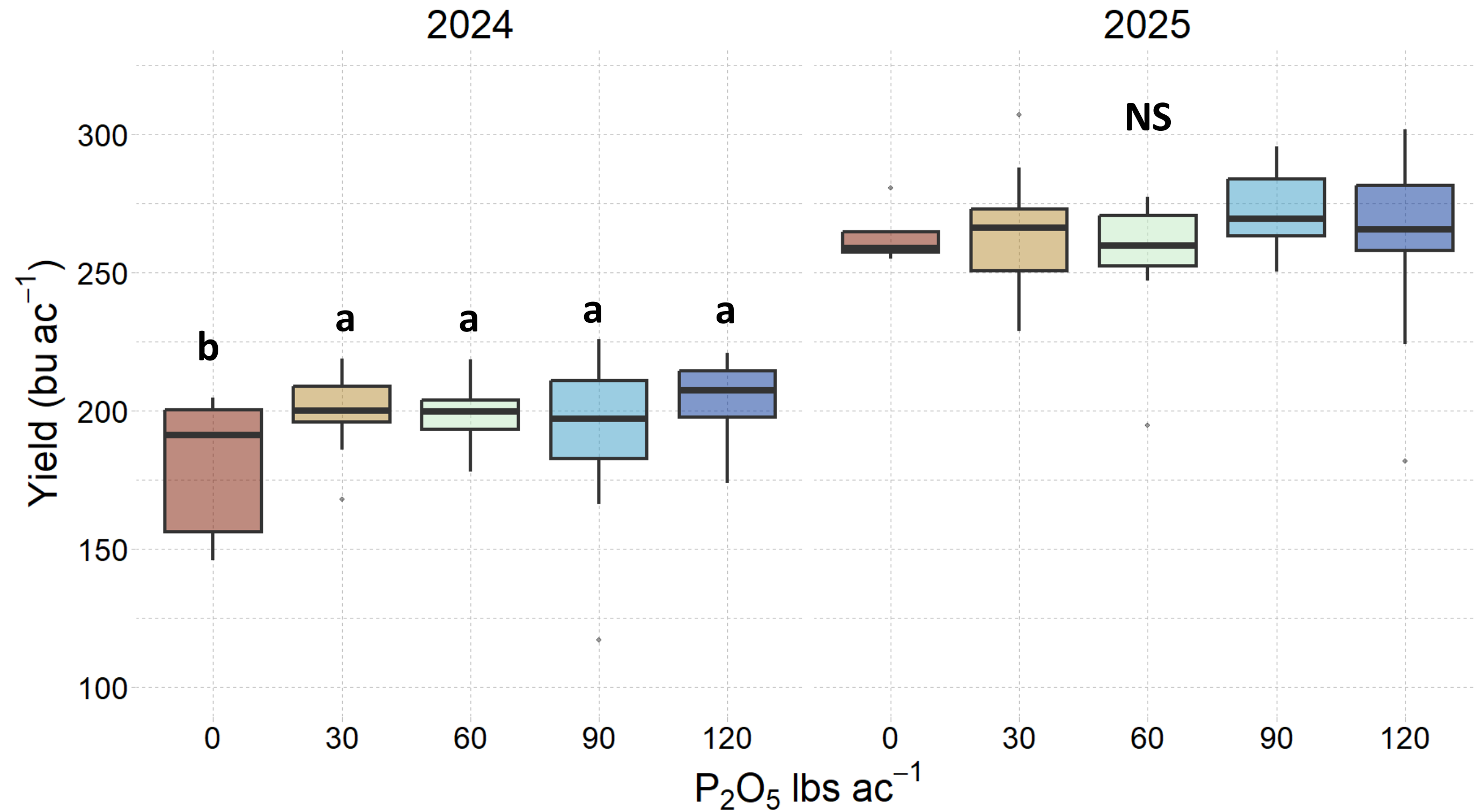
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RESULTS



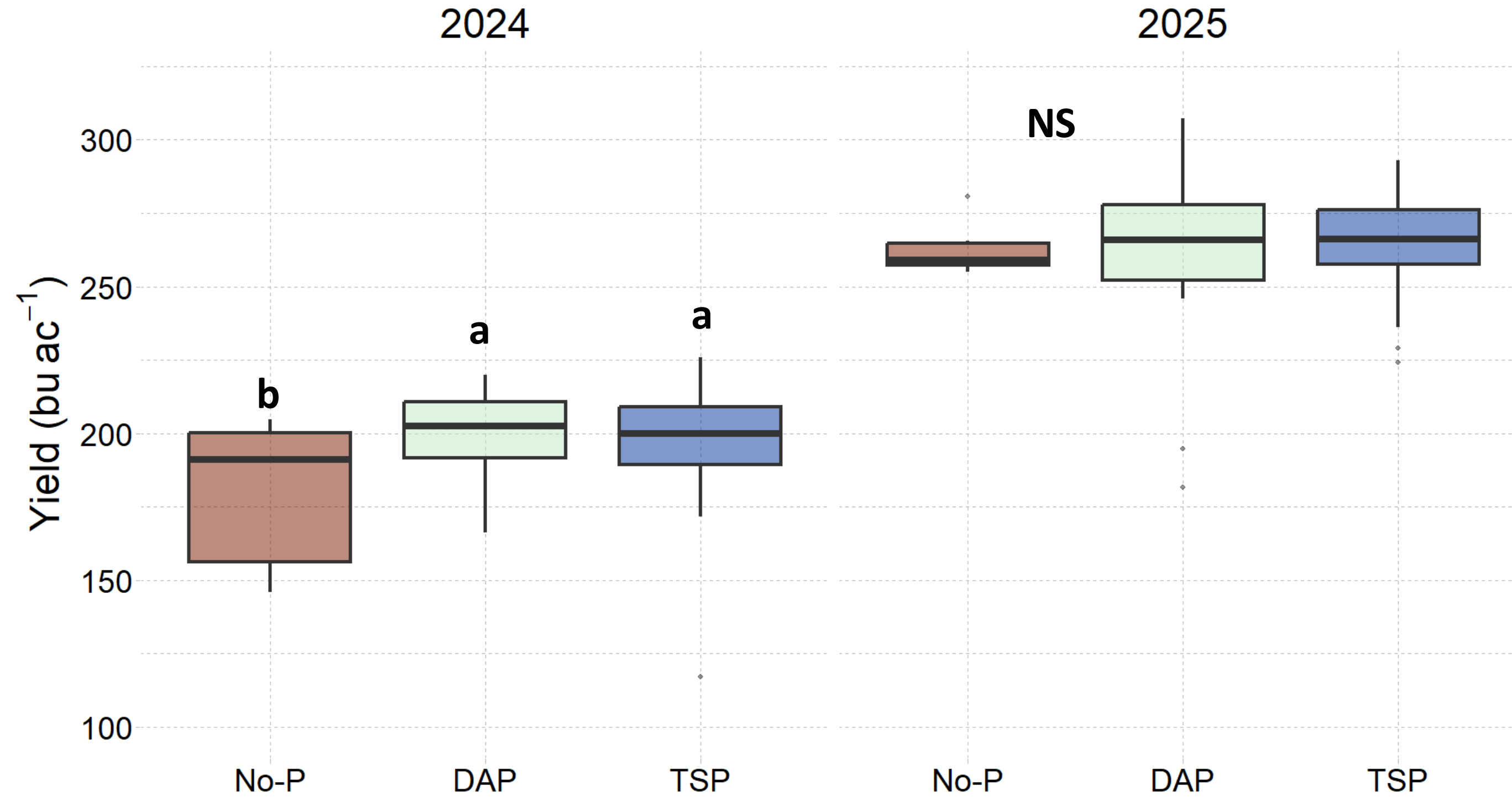
Preliminary RESULTS

Rate Response



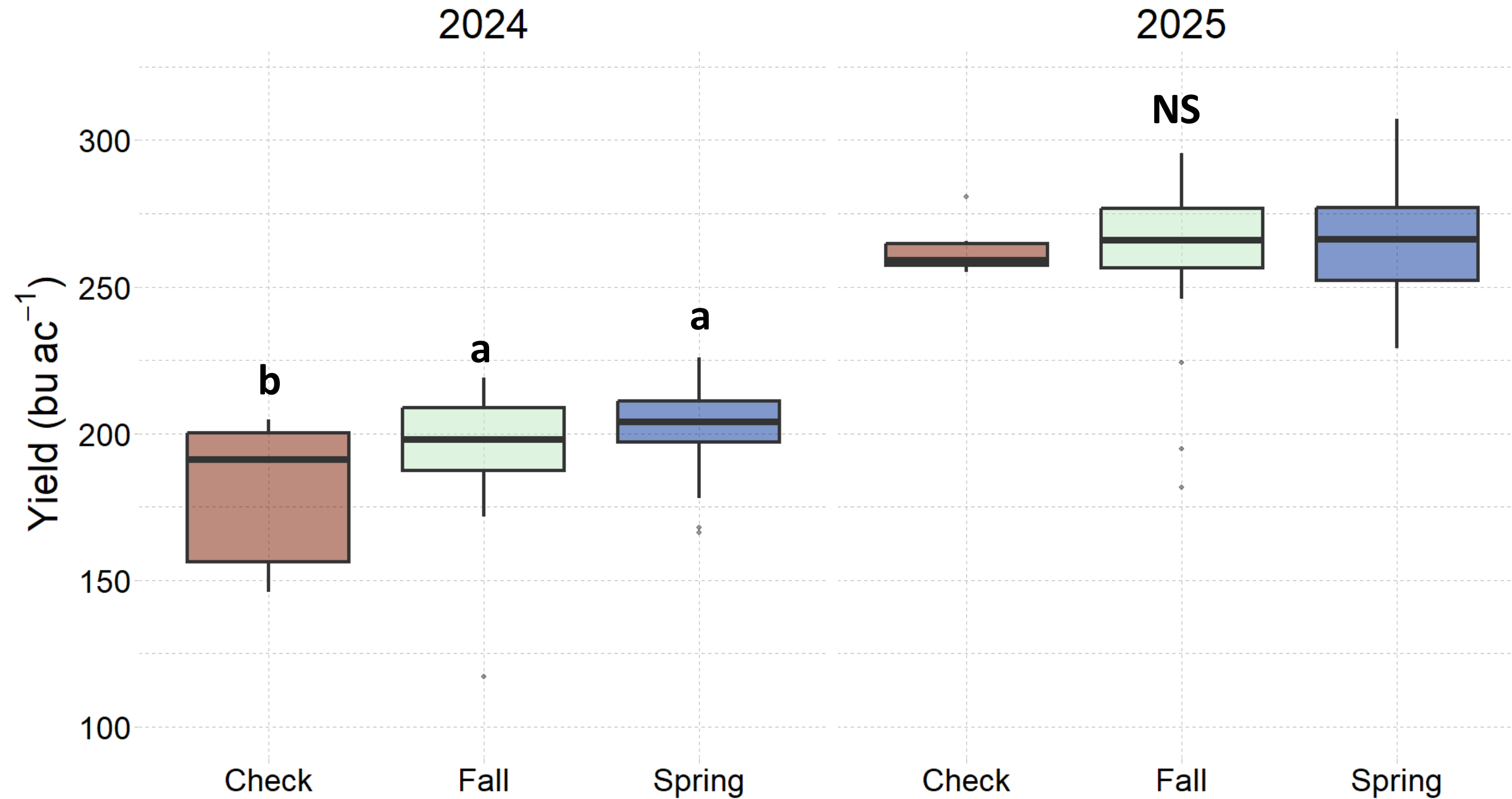
Preliminary RESULTS

Source



Preliminary RESULTS

Timing



gnificance

- Current guidelines (Olsen-P) would have us over apply by about 50 lbs P₂O₅ ac⁻¹ in year 1, and **40 lbs P₂O₅ ac⁻¹** in year 2.
- Further clarity is needed with Mehlich-3

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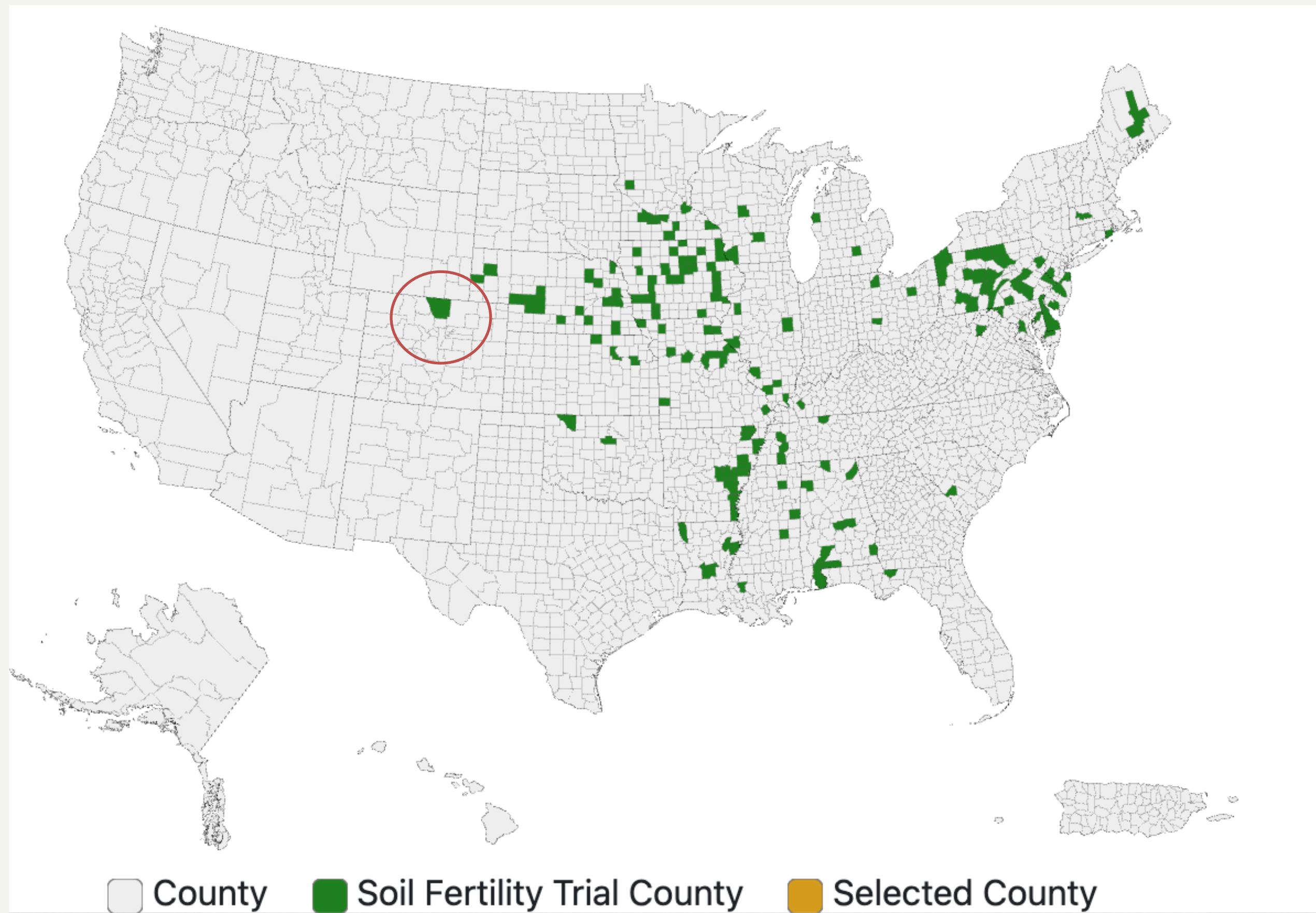
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J. Mott and G. L. Miner, unpublished data.

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> 35	> 22	Very High	0	0

Fertilizing Irrigated Corn. Jessica Davis, A.J. Brown, and Leo Deiss. Colorado State University Extension .

gnificance



Sponsors



Partners





THANK YOU

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