Does Fertilizer Source Affect the Availability of Fall-Applied Nutrients for Maize?

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Open Science Inspires

Why is this important?

- In 2022, 70% of the P and K fertilizer in Illinois was fall-applied (IDOA, 2022).
- 87% of the P fertilizer used in Illinois in 2022 consisted of ammonium phosphate fertilizers (IDOA, 2022).
- Fall N applications increase the potential for nonpoint source pollution.
- Could growers account for the fall-applied N that comes along with the P from ammonium phosphates?

Why is this important?

- The market now offers several premium co-granulated P and K fertilizer sources that can also provide nutrients such as S and B, which are soil-mobile nutrients.

- Utilizing co-granulated fertilizer sources with varying solubility for soil-mobile nutrients may help mitigate leaching issues.

Objective

Assess the effect of different fertilizer sources applied in the fall on the availability and distribution of these nutrients in the soil profile

Fertilizer Sources and Rates Applied

Treatment†	Nutrient Rate (kg ha^{-1})				
	N	P_2O_5	K_2O	S	B
Untreated control (UTC)	-	-	-	-	-
Monoammonium phosphate (MAP)	19	90	0	0	0
Ammonium sulfate (AMS)	20	0	0	22	0
MicroEssentials S10 (MES10)	27	90	0	22	0
Muriate of potash + Boron (MOP+B‡)	0	0	67	0	0.6
Aspire	0	0	67	0	0.6

† Broadcast-applied and lightly incorporated in the fall after soybean harvest.

‡ Spray of liquid boron 10%, Winfield United

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Fertilizer Sources and Rates Applied

Treatment	Nutrient Rate (kg ha^{-1})				
	N	P_2O_5	K_2O	S	B
Untreated control (UTC)	-	-	-	-	-
Monoammonium phosphate (MAP)	19	90	0	0	0
Ammonium sulfate (AMS)	100% sulfate sulfur				0
MicroEssentials S10 (MES10)®	27	90	0	22	0
Muriate of potash + Boron (MOP+B†)	0	0	67	0	0.6
Aspire®	0	0	67	0	0.6

†Liquid Boron 10%, Winfield United

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Fertilizer Sources and Rates Applied

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	N	P_2O_5	K_2O	S	B
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Ammonium sulfate (AMS)	0	0	0	0	0
MicroEssentials S10 (MES10®)	0	0	0	0	0
Muriate of potash + Boron (MOP+B†)	0	0	67	0	0.6
Aspire®	0	0	67	0	0.6

Ammonium phosphate
+
50% sulfate sulfur
+
50% elemental sulfur

†Liquid Boron 10%, Winfield United

Fertilizer Sources and Rates Applied

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Untreated control (UTC)					
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Ammonium sulfate (AMS)					
MicroEssentials S10 (MES10)®	27	90	0	22	0
Muriate of potash + Boron (MOP+B)	0	0	67	0	0.6
Aspire®	0	0	67	0	0.6

Muriate of potash

+

Boric acid spray

Liquid Boron 10% (Winfield United)

†Liquid Boron 10%, Winfield United

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Fertilizer Sources and Rates Applied

Treatment	Nutrient Rate (kg ha^{-1})				
Untreated contro					
Monoammonium					
Ammonium sulfa					
MicroEssentials [illegible]					
Muriate of potash + Boron (MOP+B†)	0	0	67	0	0.6
Aspire®	0	0	67	0	0.6

Muriate of potash

+

50% sodium tetraborate anhydrous

+

50% calcium hexaborate pentahydrate

†Liquid Boron 10%, Winfield United

Trial Measurements Timeline

Fall Broadcast Fertilization on Soybean Stubble

Soil Sample 1

Maize Preplant Spring Soil Sample (Year 1)

Soil Sample 2

Maize Postharvest Fall Soil Sample (Year 1)

- **0-15 cm**
- **15-30 cm**
- **30-60 cm**
- **60-90 cm**

Soil Sample 3

Soybean Preplant Spring Soil Sample (Year 2 - Residual)

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Total of 5472 soil cores
= 1368 composite soil samples

Trial Location

- The trial was replicated over 4 years (2020-2023) in different fields located in Champaign, IL.
- Flanagan and Drummer silty clay loams (Mollisols).
- Fields were conventionally tilled in a maize-soybean rotation.

Soil Test Results

Fall-applied N, S, and B

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Maize Preplant Soil Samples

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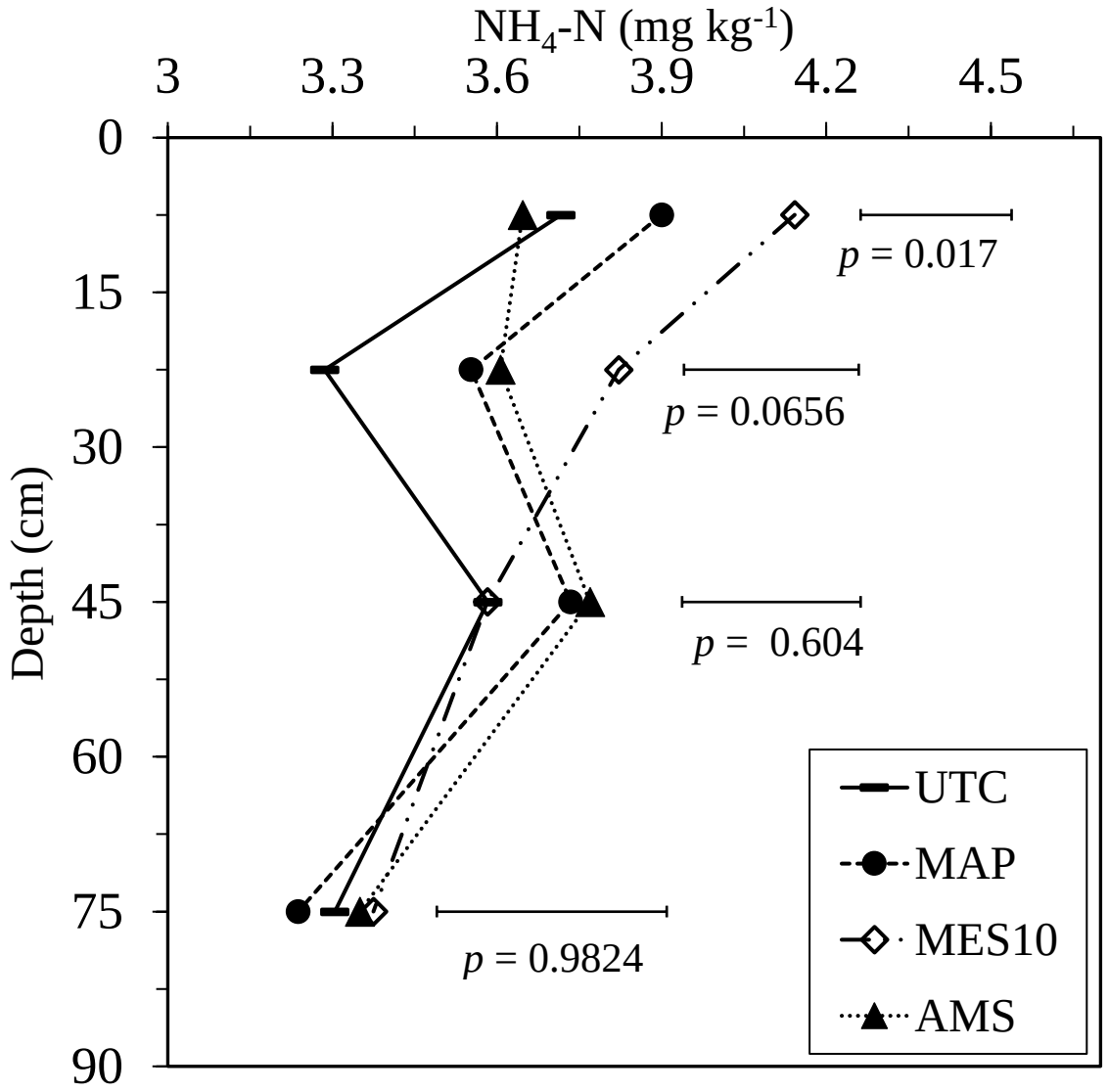
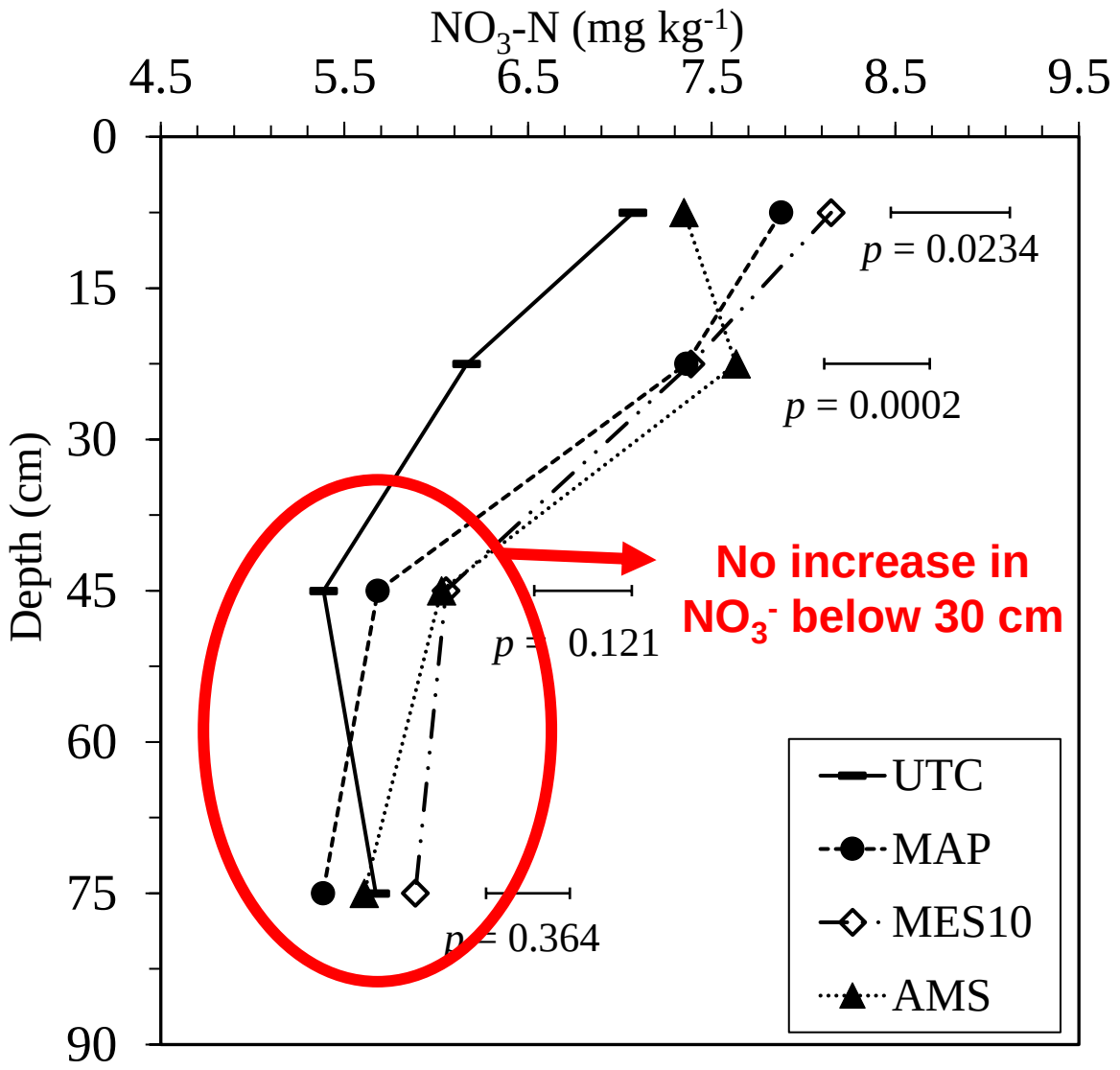
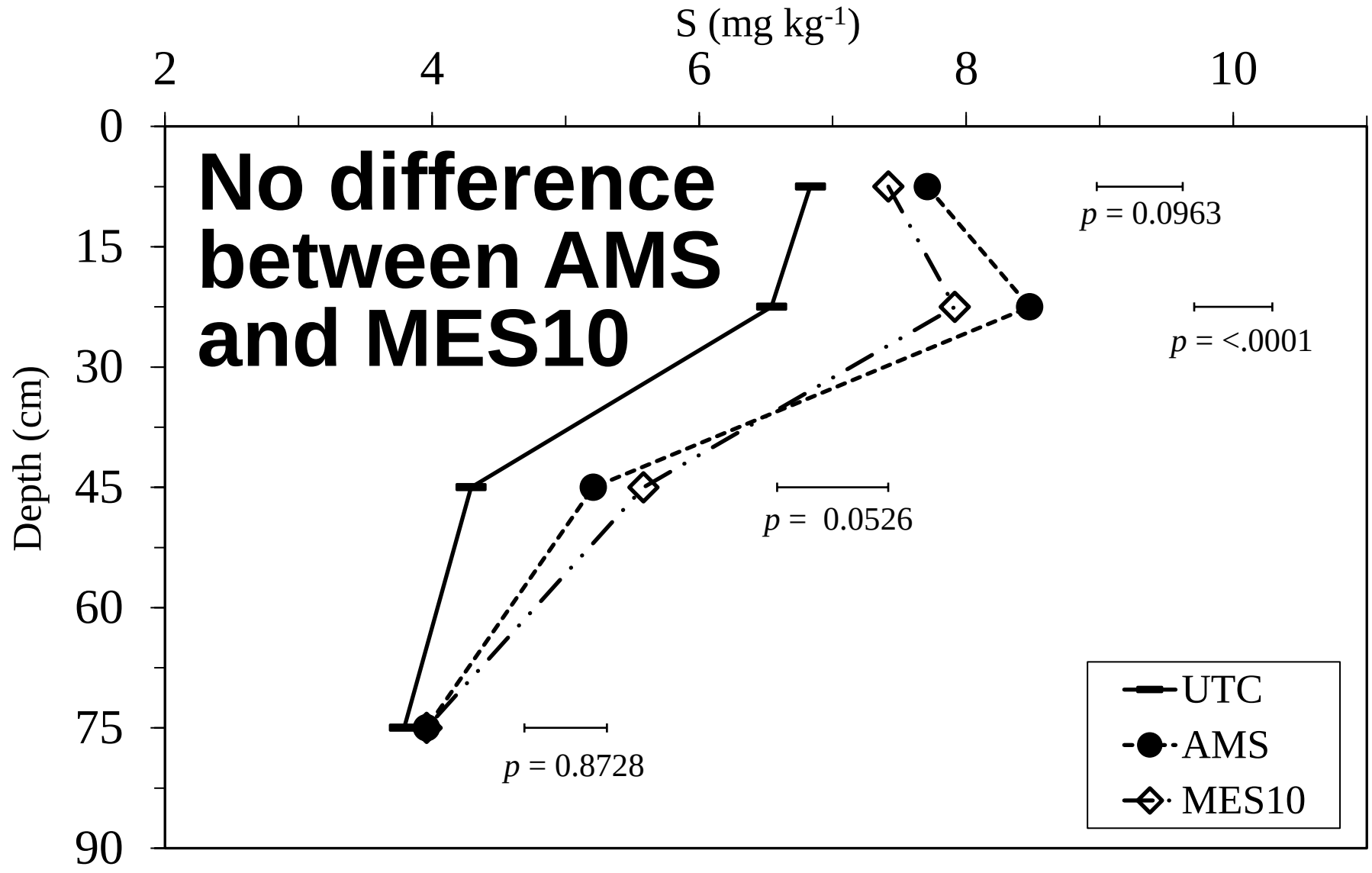
Spring NH_4-N & NO_3-N Availability





- Horizontal bars represent the least significant difference within a soil depth by the Fisher test at $P = 0.1$. Champaign, IL (2020-23)

Maize Preplant Sulfur Availability



- Horizontal bars represent the least significant difference within a soil depth by the Fisher test at $P = 0.1$.

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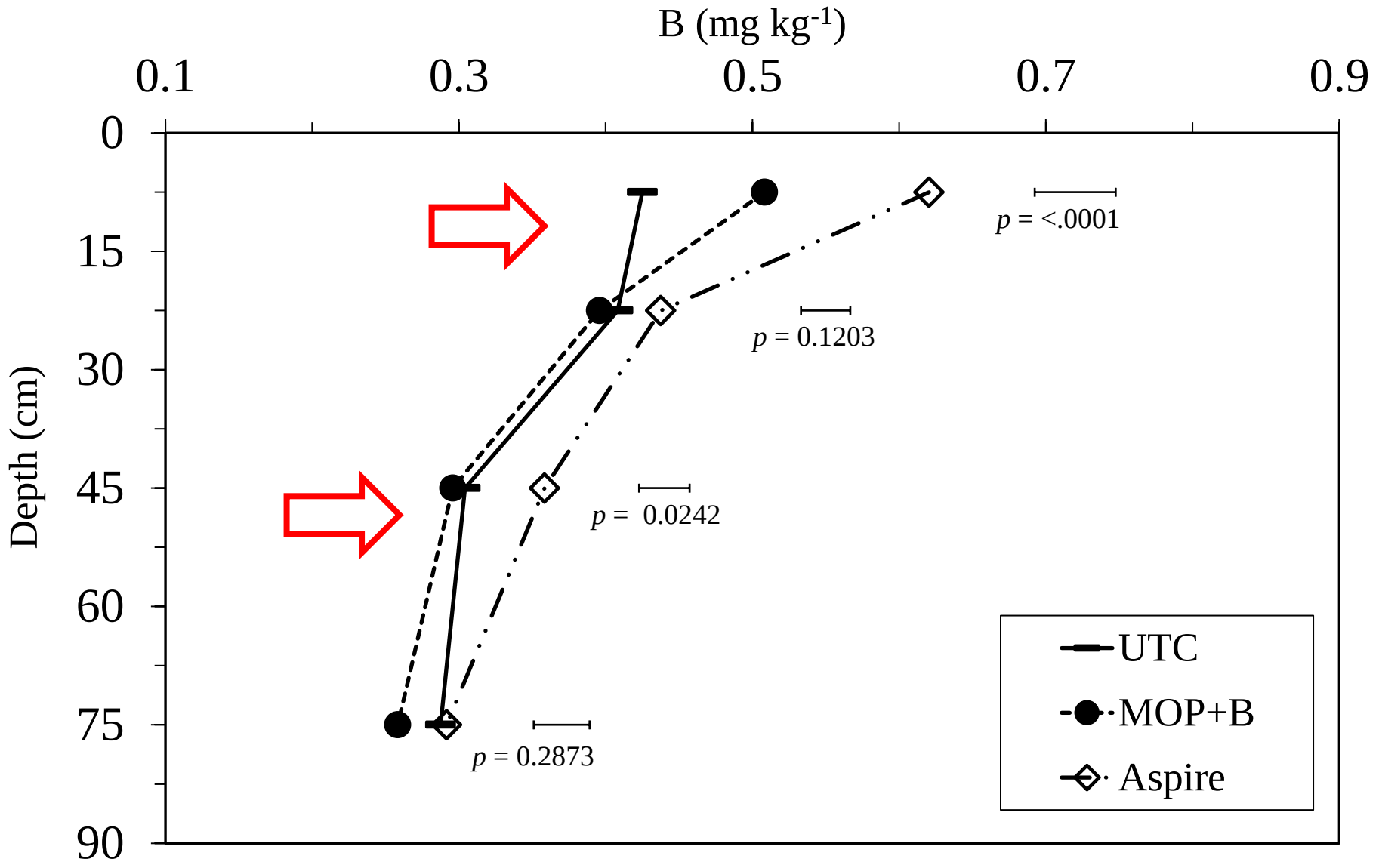
Maize Preplant Boron Availability



- Horizontal bars represent the least significant difference within a soil depth by the Fisher test at $P = 0.1$.

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Spring N, S, and B Apparent Recovery

Fertilizer Treatment	Apparent recovery		
	Nitrogen	Sulfate-S	Boron
	% of applied		
MAP	15.9	-	-
AMS	31.2	45.8	-
MES10®	31.7	47.1	-
MOP+B	-	-	-8
Aspire	-	-	123.4
LSD ($P \leq 0.10$)	NS	NS	51.7
p-value	0.7044	0.936	0.0002

Estimated by subtracting soil N, S, or B concentration in the control plot from that of the treated plots and dividing by the applied nutrient rate**.** Average of four years of data (2020-23).

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Spring N, S, and B Apparent Recovery

Averaged across sources, 74% of the fall-applied N was not plant-available in the spring (0-90 cm)

p-value	0.7044	0.936	0.0002

Estimated by subtracting soil N, S, or B concentration in the control plot from that of the treated plots and dividing by the applied nutrient rate. *Average of four years of data (2020-23).*

Maize Postharvest Soil Samples

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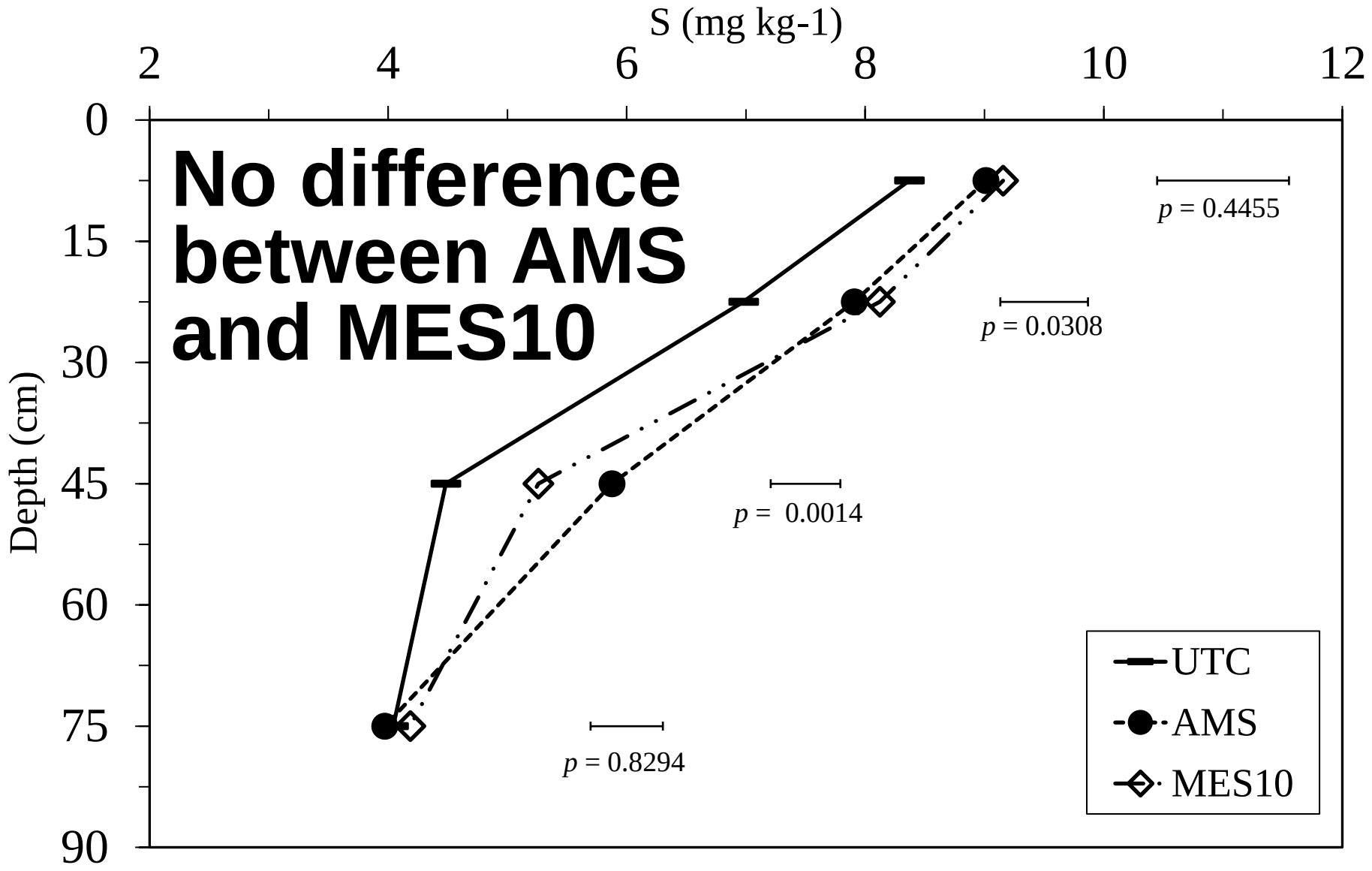
Maize Postharvest Sulfur Availability



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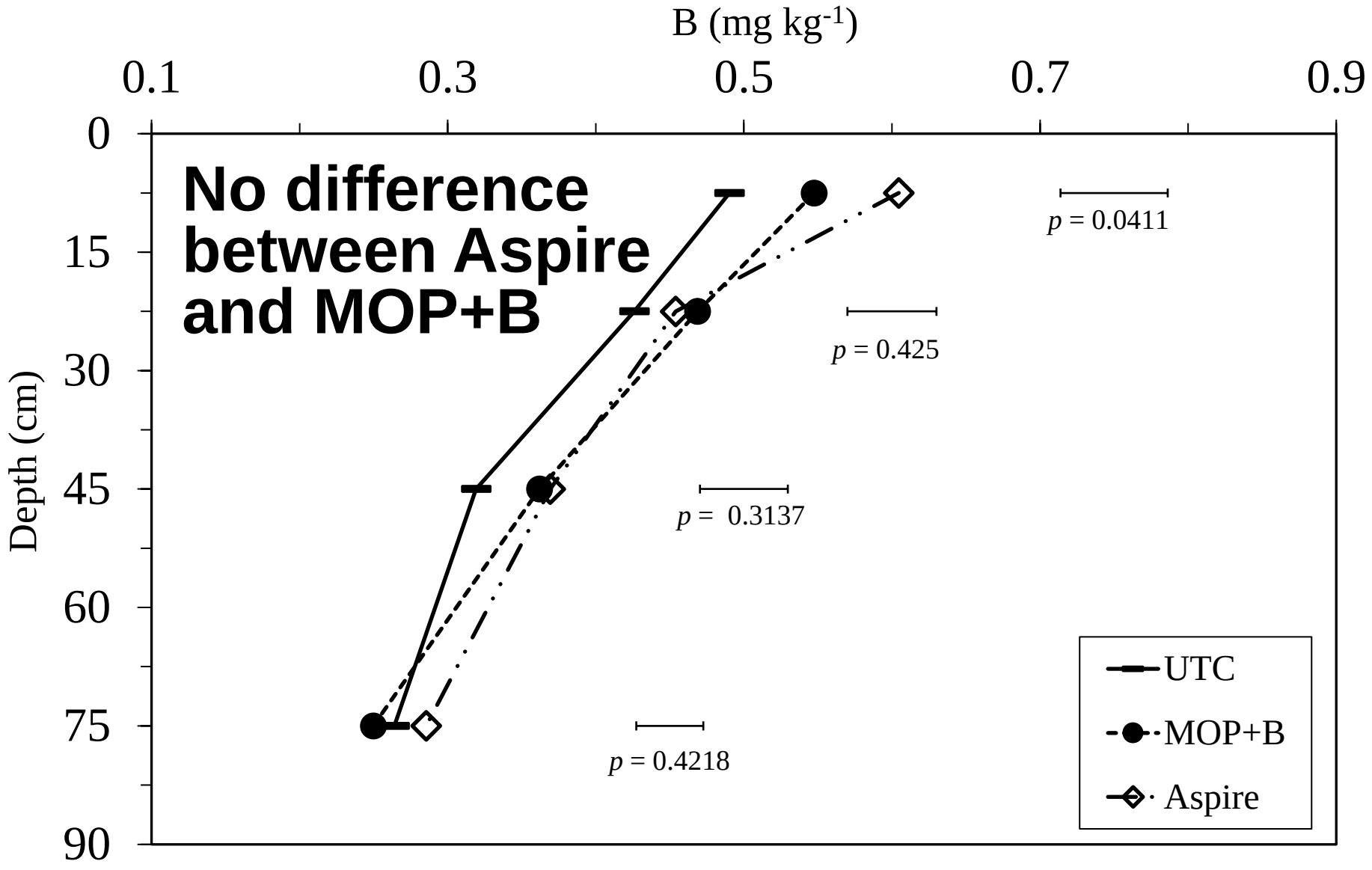
Maize Postharvest Boron Availability



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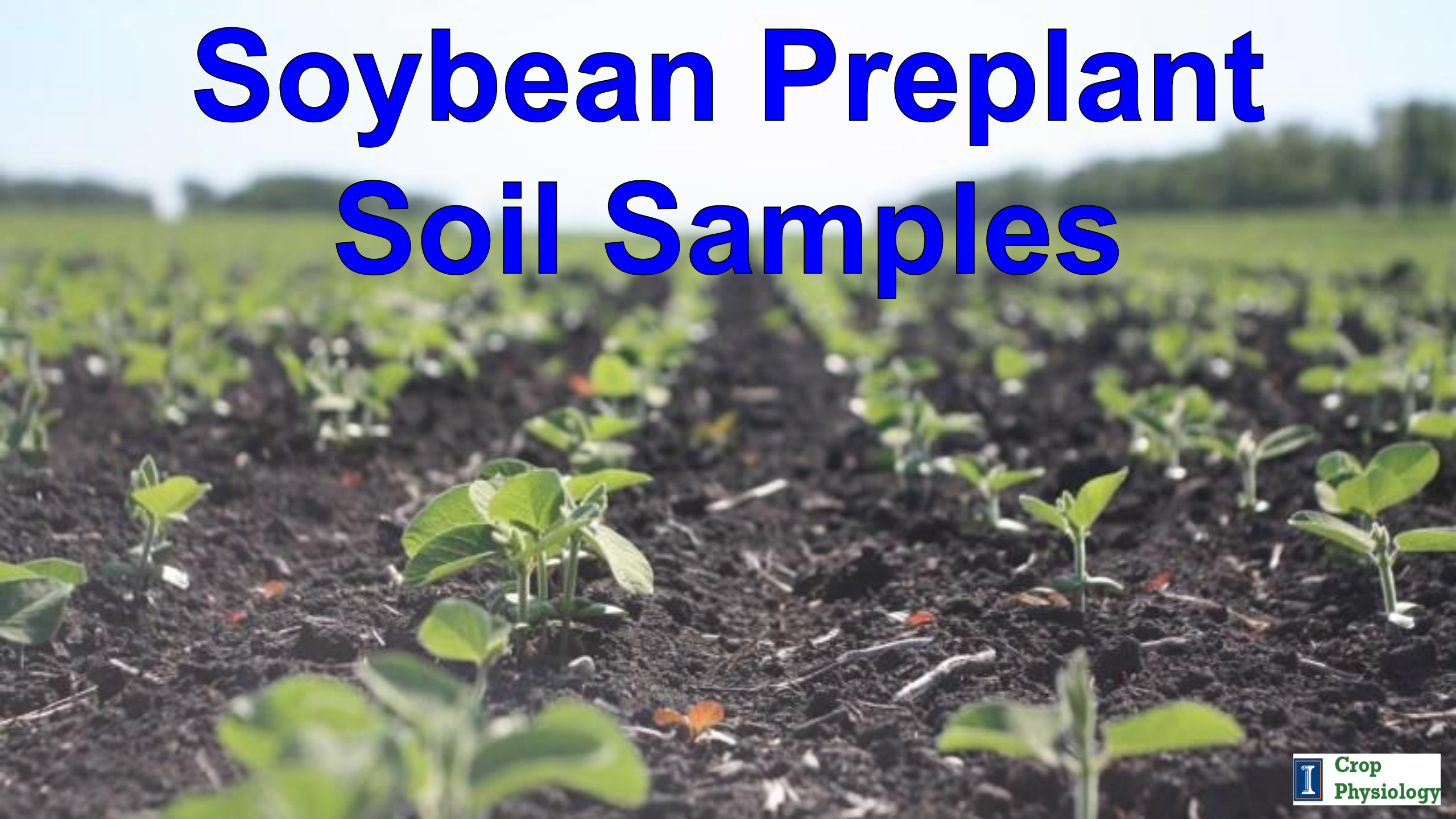
Soybean Preplant Soil Samples



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Soybean Preplant Sulfur Availability

Treatment	Soil Sample Depth	
	0-15 cm	15-30 cm
	S (mg kg^{-1})	
UTC	5.9	5.9
AMS	5.8	6.4
MES10	6.4	6.9
LSD ($P \leq 0.10$)	0.5	0.8
p-value	0.0634	0.0711

Average of four years of data (2020-23).

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Soybean Preplant Boron Availability

Treatment	Soil Sample Depth	
	0-15 cm	15-30 cm
	B (mg kg^{-1})	
UTC	0.48	0.42
MOP+B	0.50	0.47
Aspire	0.57	0.52
LSD ($P \leq 0.10$)	0.05	0.05
p-value	0.0102	0.0046

Average of four years of data (2020-23).

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Does Source Matters?

- **Most of the fall-applied N was not plant available at maize planting.**
- **Sulfur source only affected soil S availability for the subsequent soybean crop (residual effect).**
- **Boron source affected soil B availability at maize planting and the subsequent soybean crop.**

Crop Physiology Research Team

Thank you!

Questions?