Soil and Tissue Test Based Nutrient Management for Corn, Soybean, and Cotton

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Most Frequently Asked Questions……..

Q1. What is the optimum N rate and timing for 200 bu corn?

Q2. What is the best time to apply P & K – Fall or Spring?

Q3. Can we cut down P & K fertilizer rates and how much?

Q4. Can we fertilize in-season P & K and recover yield losses in low to medium testing soils?

Q5. Is liquid P, K, & S fertilizer better than granular fertilizer?

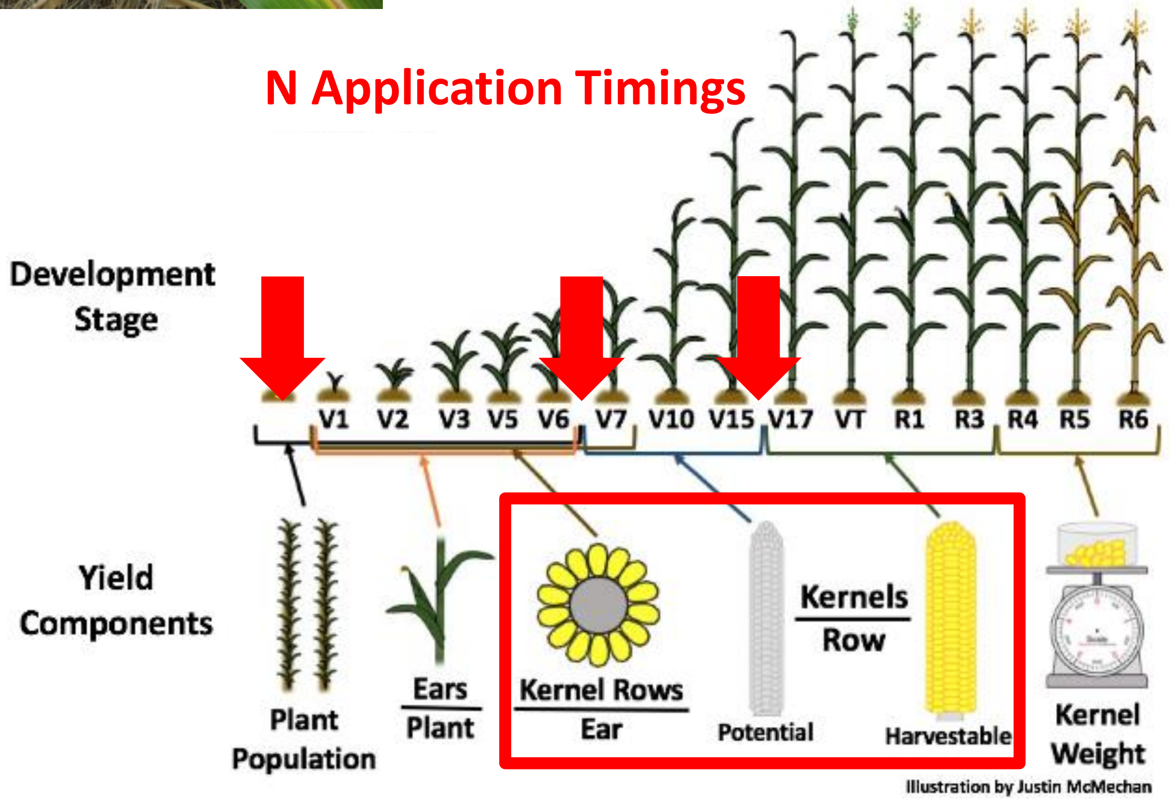
- ❖ **How good is our soil-test-based S recommendations?**
- ❖ **Omission trial – how do crop inputs interact each other?**

Q1. What is the optimum N rate & timing for corn?

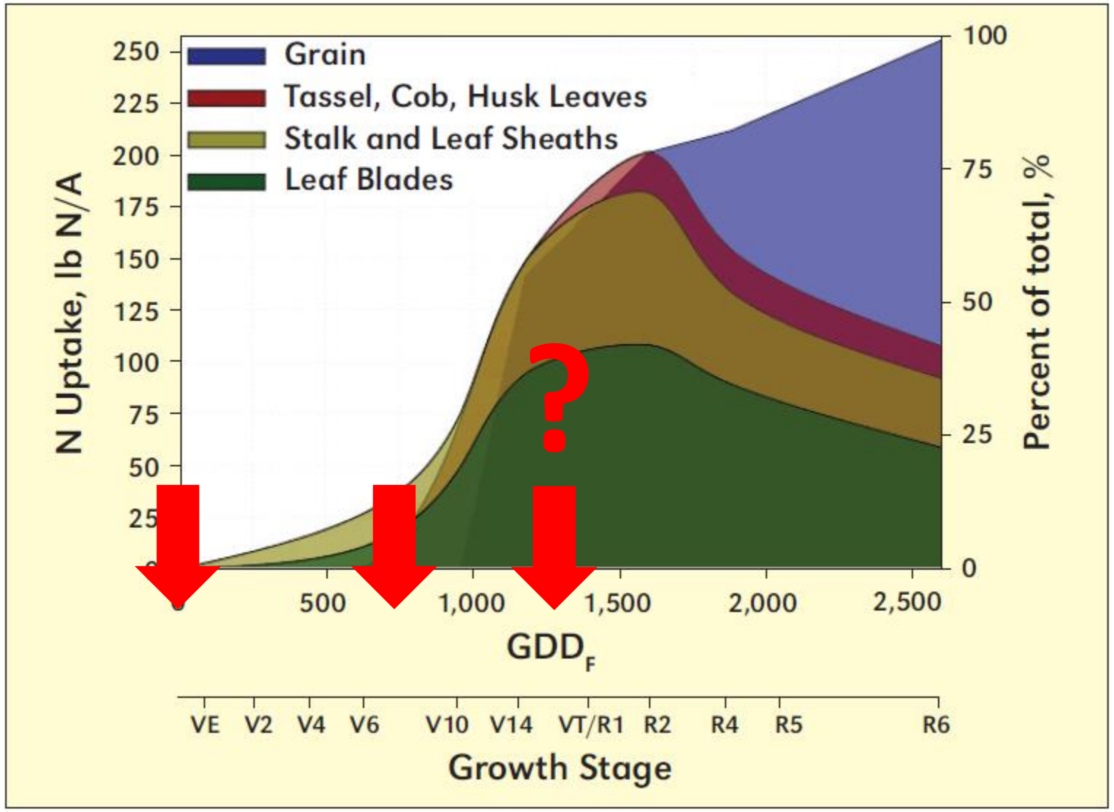
Soil Type	N Rate (lb N/bu)	Target N Rate 2022
Sandy/Silt Loam	1.00	0.8
Clay	1.25	1.0

Why do clay soils need more N?

1. Higher CEC – fix more applied N
2. Complex N uptake route

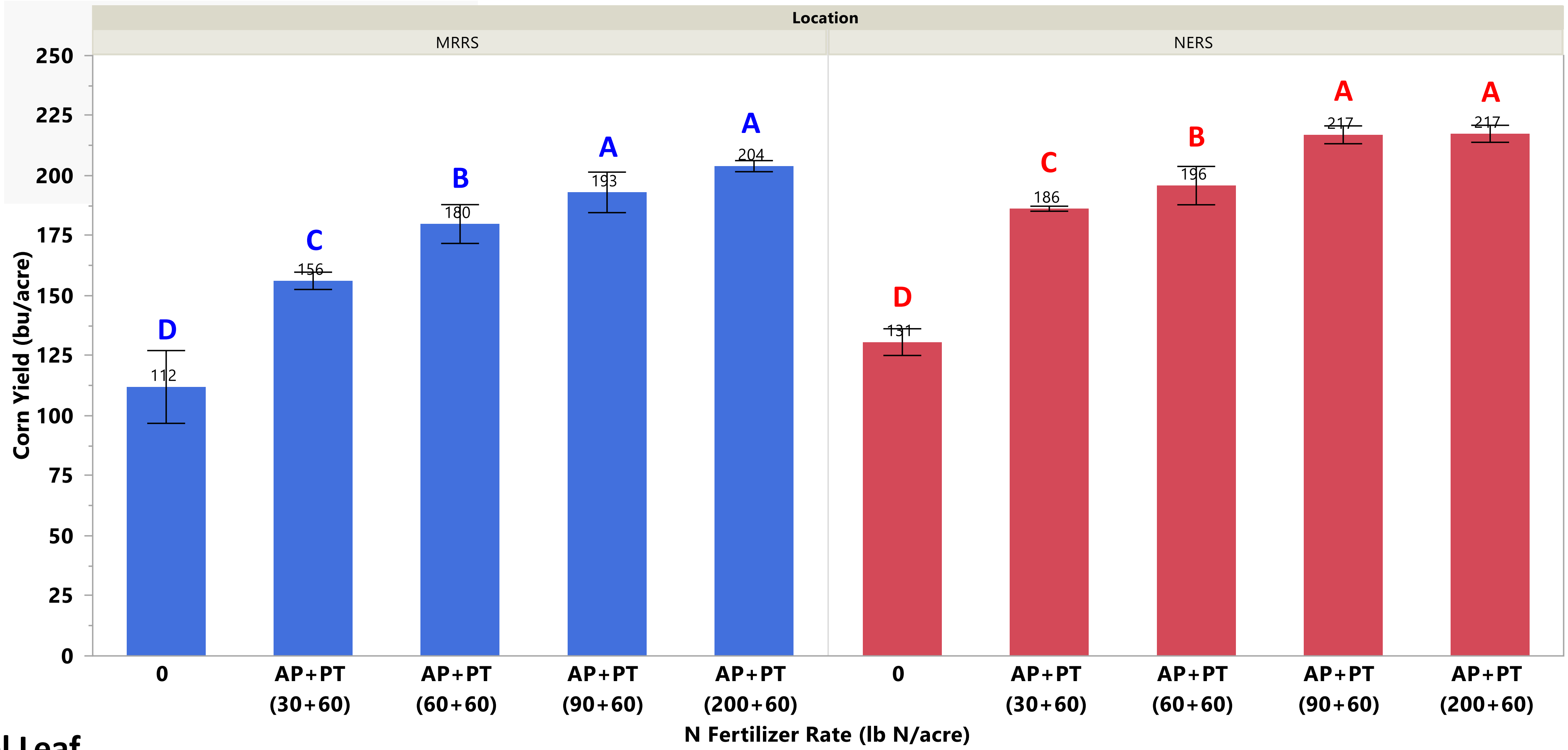


University of Nebraska



Bender et al. (2012)

Split N Application



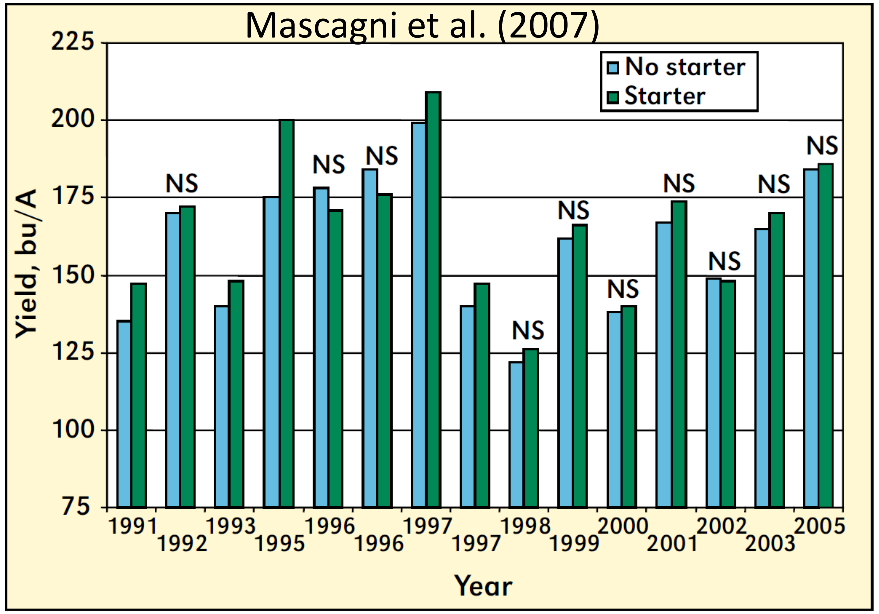
Pre-Tassel Leaf N Concentration	2.0%	2.2%	2.3%	2.7%	2.8%	2.3%	2.9%	2.9%	3.1%	3.2%

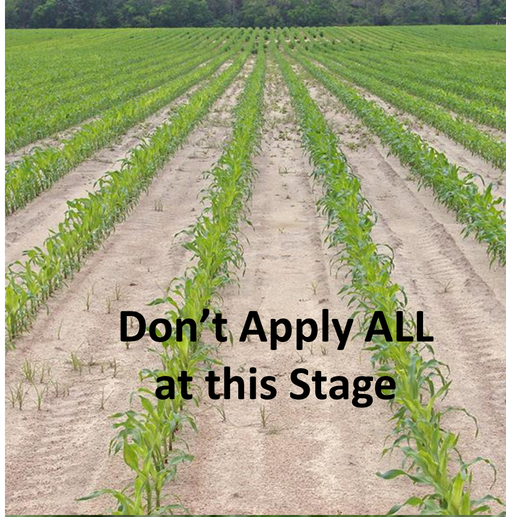
Sufficient N concentration is > 3%

Optimum N Rate & Timing

Soil Type	Yield Goal (bu/acre)	N Rate (lb N/bu)	N Rate 2022	Split Application (Planting – V6/7)	N-Fertilizer Sources
Silt Loam	~200	1.00	0.8	30/45 – 115/130	Planting: 32-0-0 V7/8: 28-0-0-5S
Clay	~200	1.25	1.0	45/60 – 140/155	

Do we need starter fertilizer (10-34-0; 5 gal/acre)?



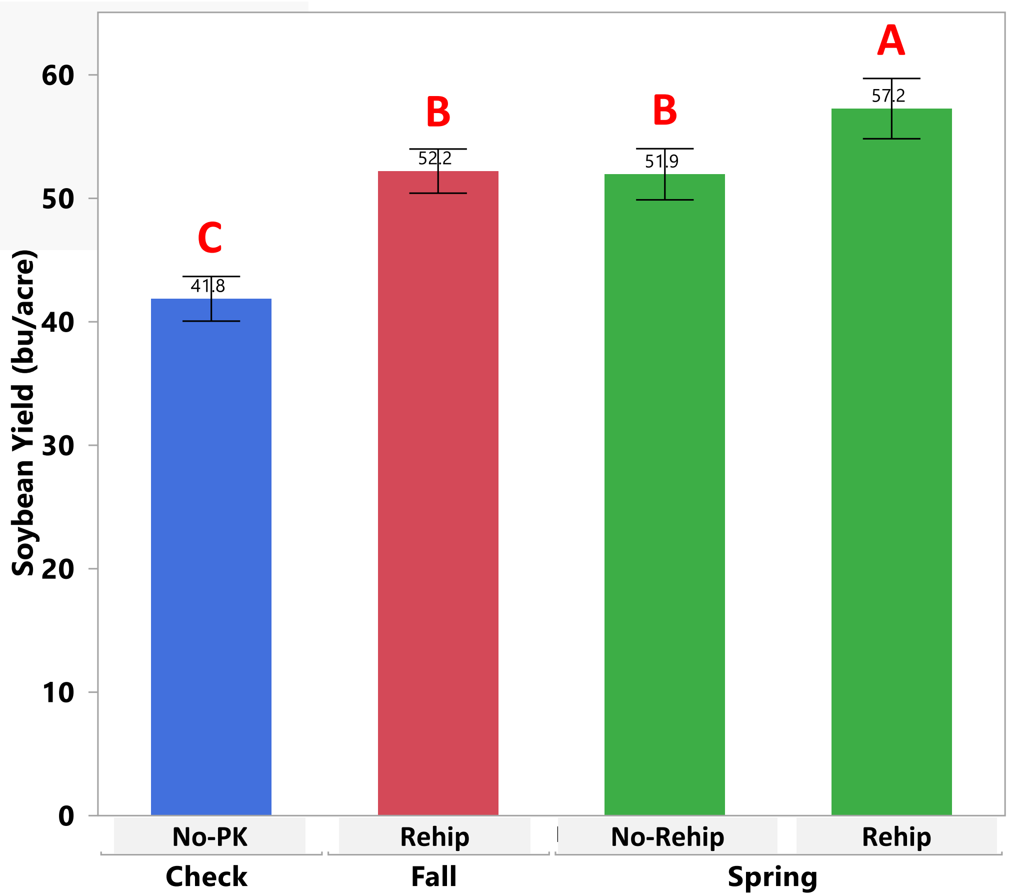


Q2. What's the best time to apply P&K?

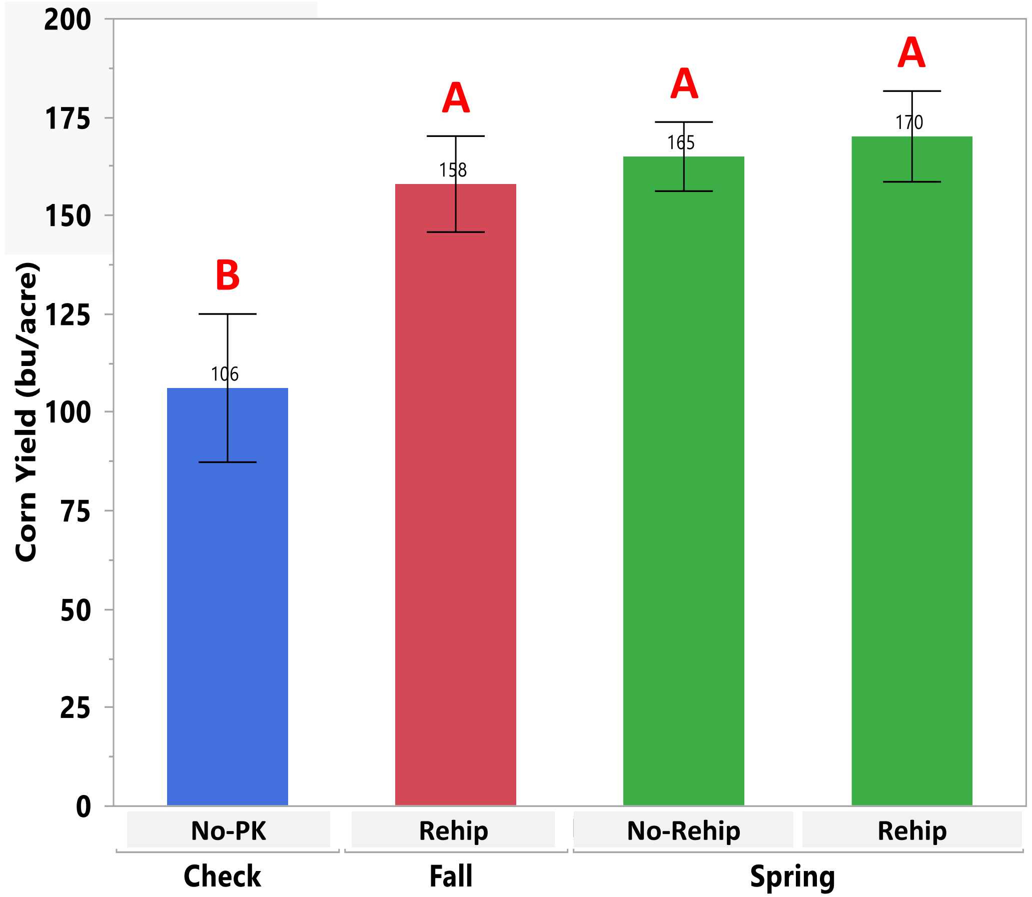
Fall vs. Spring Application

Fall vs. Spring P & K Application Timings

Soybean Yield



Corn Yield



Fall vs. Spring P & K Application Considerations

Fall Application

- ✓ Clayey soils with high CEC (>25).
- ✓ Maintenance rate in soils within (medium) or above (sufficient) the critical P & K levels.
- ✓ Fields that have a long history of chloride (Cl) toxicity problems and are poorly drained – apply K (potash; KCl) to decrease Cl toxicity through winter and early spring rainfall.

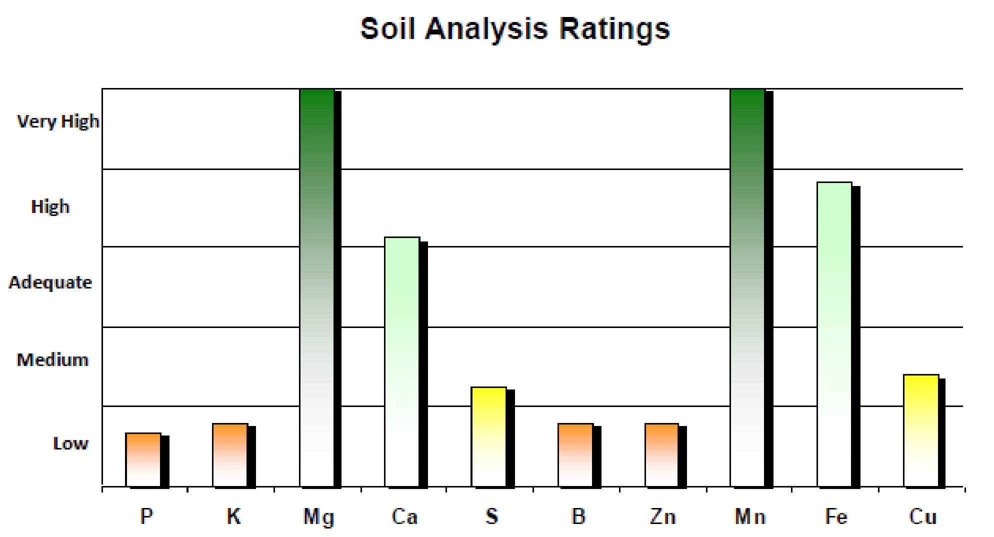
Spring Application

- ✓ P and K deficient soils – to reduce fixation time and ensure maximum P&K availabilities.
- ✓ Low (pH <5.5) or high (pH >7.5) pH soils – apply P in to ensure maximum P availability.
- ✓ Coarse-textured soils with very low CEC (<10) – to reduce nutrient leaching and runoff.
- ✓ Soils that are very prone to waterlogged/flooded conditions – to ensure availabilities.

Q3. Can we cut down P & K fertilizer rates and how much?

Soil-Testing & Crop Yield Response

Test Method: Mehlich III				Soil Laboratory Data (ppm)						Target pH 6.5	
P Phosphorus	K Potassium	Mg Magnesium	Ca Calcium	Soil pH	Buffer pH SMP	S Sulfur	B Boron	Zn Zinc	Mn Manganese	Fe Iron	Cu Copper
13.5 L	49 L	163.5 VH	724 H	5.2	6.65	15.5 M	0.4 L	1.6 L	219 VH	181.5 H	1.1 M
Al Aluminum	Na Sodium	NO3-N Nitrate-N	NH4 Ammonia	Soluble Salts		Organic Matter	ENR	Mo Molybdenum	Ni Nickel	BiCarbs	
	76	ppm	ppm	mmhos/cm		1.65 %	16.5	ppm	ppm	meq/L	

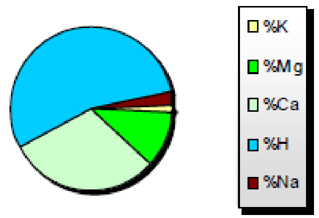


Cation Exchange Capacity	12.2	meq/100g

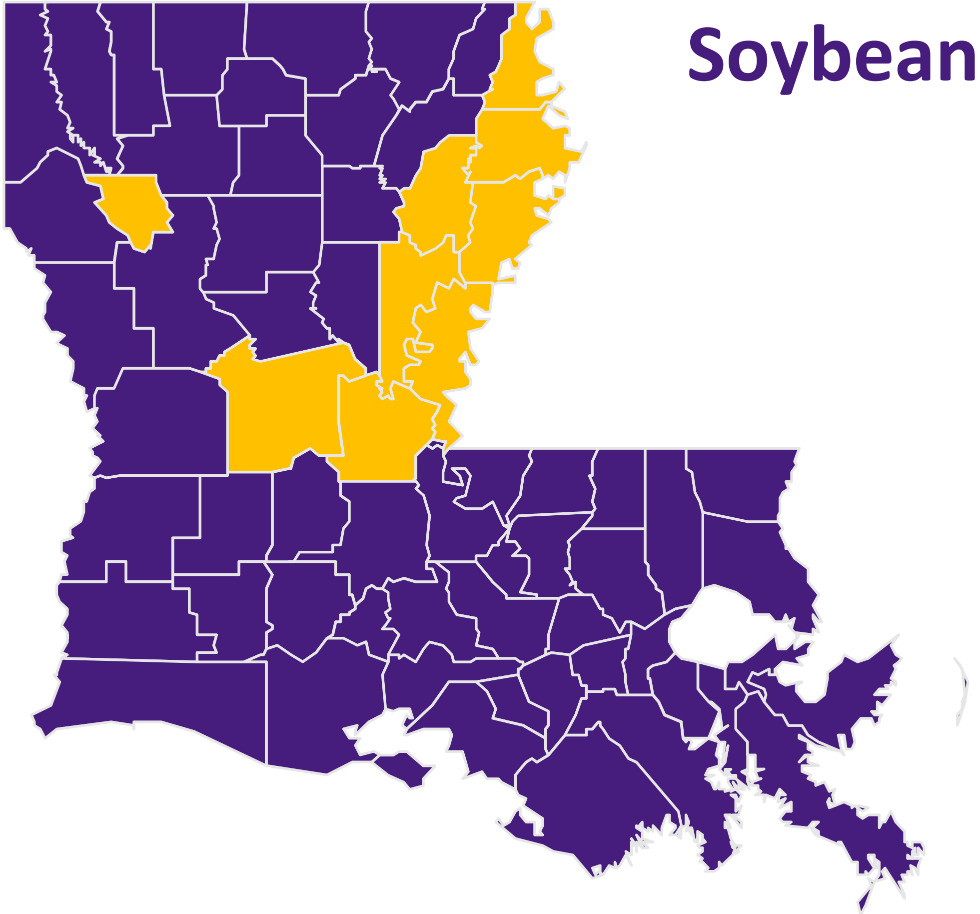
Base Saturation

K: 1.0 %	Mg: 11.1 %
Ca: 29.6 %	H: 55.6 %
Na: 2.7 %	

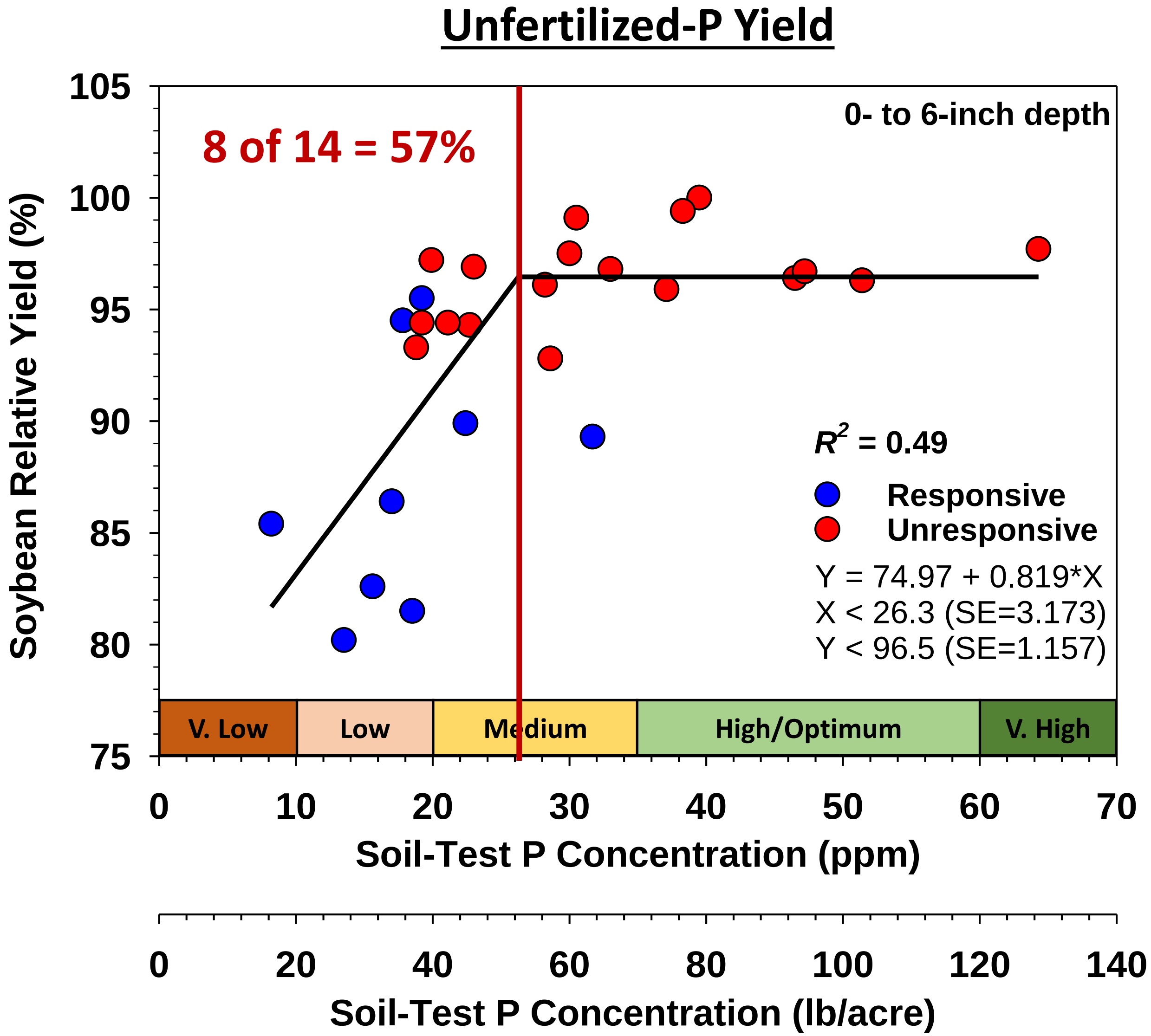
Base Saturation



Soybean Yield Response to Soil-Test P Concentration



Soil-Test Level	Mehlich-3 Soil-Test P Conc. (ppm)
All Soil Types	
Very Low	≤ 10
Low	11 – 20
Medium	21 – 35
High	36 – 60
Very High	> 60

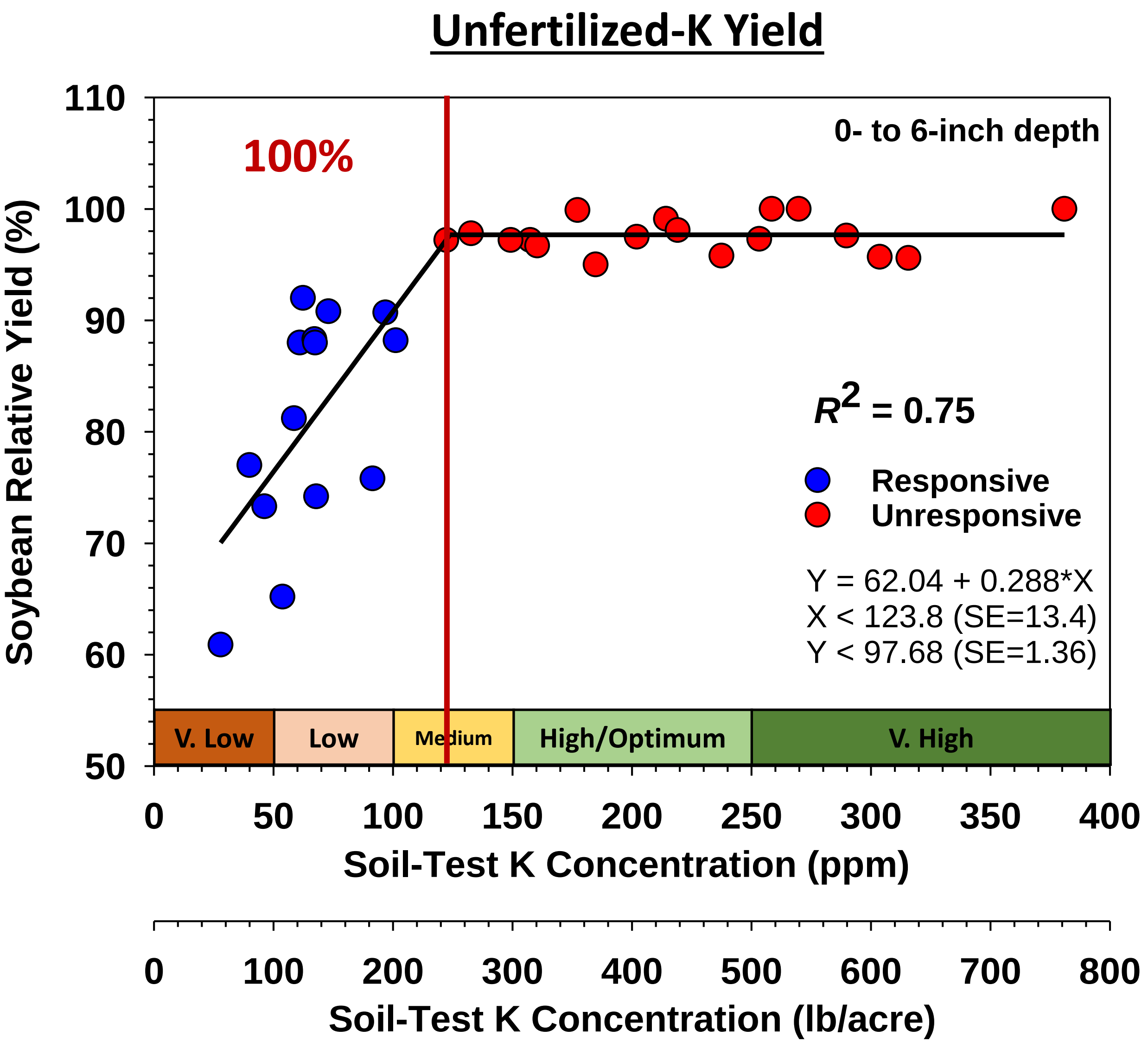


Soil-Test-Based Phosphorus (P) Recommendations

Soil-test Level	Soil-test P Concentration (ppm)	Unfertilized Yield Loss (%)	Probability of Yield Response (%)	Recommendations Soybean – Corn (lb P2O5/acre)	Recommendations (lb P2O5/acre) 2022
Very Low	**≤ 10**	~20	100	80 – 100	**60 – 70 (130-150 lb TSP)**
Low	**11 – 15**	~20	100	60 – 80	**46 (100 lb TSP)**
	16 – 20	~15	63	60 – 80	**? or 46 (100 lb TSP)**
Medium	**21 – 25**	~10	25	40 – 60	**0**
	26 – 35	0-10	17	30 – 40	**0**
High or Optimum	**36 – 60**	0	0	0	**0**
Very High	**> 60**	0	0	0	**0**

Soybean Yield Response to Soil K Concentration

Soil-Test Level	Mehlich-3 Soil-Test K Concentration (ppm)	
	Alluvial Soils	Upland Soils
Loamy Sand, Sandy Loam		
Very Low	≤ 35	≤ 35
Low	36 – 53	36 – 53
Medium	54 – 79	54 – 88
High	80 – 123	89 – 106
Very High	> 123	> 106
Very Fine Sandy Loam, Fine Sandy Loam		
Very Low	≤ 53	≤ 44
Low	54 – 88	45 – 70
Medium	89 – 123	71 – 106
High	124 – 141	107 – 123
Very High	> 141	> 123
Loam, Silt Loam		
Very Low	≤ 70	≤ 62
Low	71 – 106	63 – 97
Medium	107 – 141	98 – 141
High	142 – 158	142 – 158
Very High	> 158	> 158
Clay Loam, Silty Clay Loam		
Very Low	≤ 123	≤ 88
Low	124 – 176	89 – 141
Medium	177 – 264	142 – 176
High	265 – 282	177 – 194
Very High	> 282	> 194
Silty Clay, Clay		
Very Low	≤ 141	≤ 88
Low	142 – 211	89 – 141
Medium	212 – 317	142 – 176
High	318 – 334	177 – 194
Very High	> 334	> 194



Soil-Test-Based Potassium (K) Recommendations

Soil-test Level	Soil-test K Concentration (ppm)	Unfertilized Yield Loss (%)	Probability of Yield Response (%)	Recommendations Soybean – Corn (lb K2O/acre)	Recommendations (lb K2O/acre) 2022
Very Low	≤ 50	~40	100	100 – 120	80 – 90 (130-150 lb Potash)
Low	51 – 75	~35	100	80 – 100	60 – 70 (100-117 lb Potash)
	76 – 100	~25	100	60 – 80	40 – 60 (67-100 lb Potash)
Medium	101 – 125	~10	50	40 – 60	0
	126 – 150	0	0	30 – 40	0
High or Optimum	151 – 250	0	0	0	0
Very High	> 250	0	0	0	0

K-Rate Recommendations Heads-up

Soil-test Level	Soil-test K Concentration (ppm)		Recommendations (lb K2O acre[-1])
	Alluvial Soils	Upland Soils	
Loamy Sand, Sandy Loam			
Very Low	≤ 35	≤ 35	80
Low	36 – 53	36 – 53	60
Medium	54 – 79	54 – 88	30
High	80 – 123	89 – 106	0
Very High	> 123	> 106	0
Very Fine Sandy Loam, Fine Sandy Loam			
Very Low	≤ 53	≤ 44	80
Low	54 – 88	45 – 70	60
Medium	89 – 123	71 – 106	30
High	124 – 141	107 – 123	0
Very High	> 141	> 123	0
Loam, Silt Loam			
Very Low	≤ 70	≤ 62	80
Low	71 – 106	63 – 97	60
Medium	107 – 141	98 – 141	30
High	142 – 158	142 – 158	0
Very High	> 158	> 158	0
Clay Loam, Silty Clay Loam			
Very Low	≤ 123	≤ 88	80
Low	124 – 176	89 – 141	60
Medium	177 – 264	142 – 176	30
High	265 – 282	177 – 194	0
Very High	> 282	> 194	0
Silty Clay, Clay			
Very Low	≤ 141	≤ 88	80
Low	142 – 211	89 – 141	60
Medium	212 – 317	142 – 176	30
High	318 – 334	177 – 194	0
Very High	> 334	> 194	0

Soil-test Level	Soil-test K Concentration (ppm)	Recommendations (lb K2O acre[-1])
	All Soil Types	
Very Low	≤ 60	160
Low	61 – 90	120
Medium	91 – 130	60
Optimum	131 – 175	50
Very High	> 175	0

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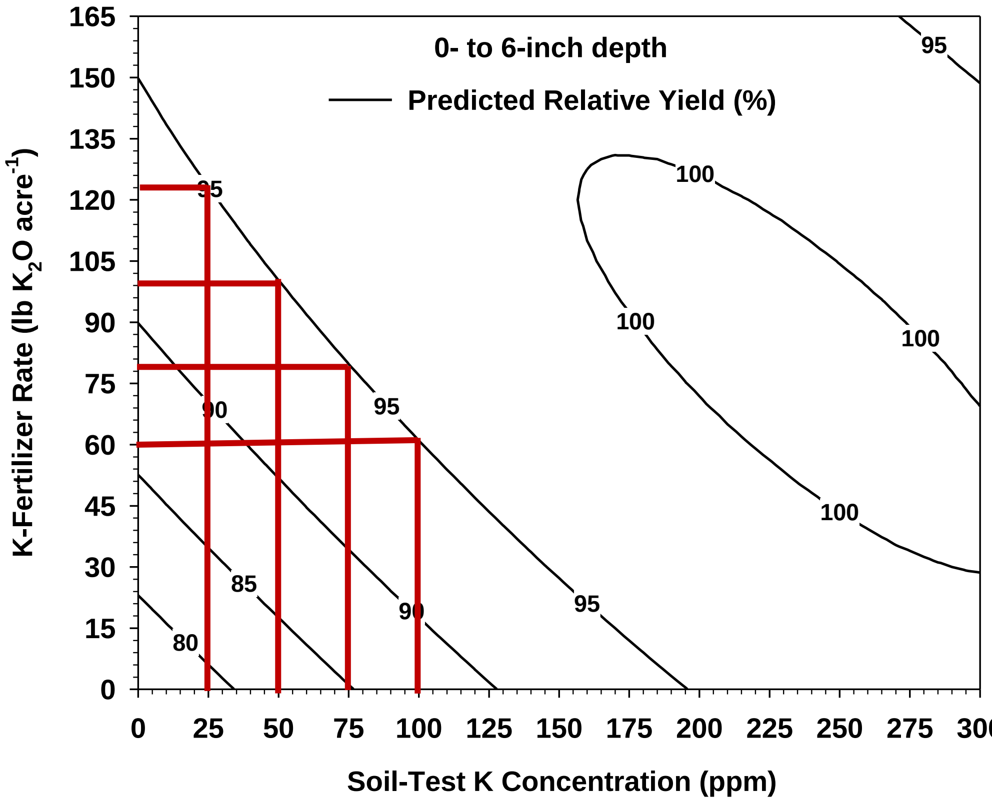


Soil-Test K Conc. vs. K Saturation for K Recommendations

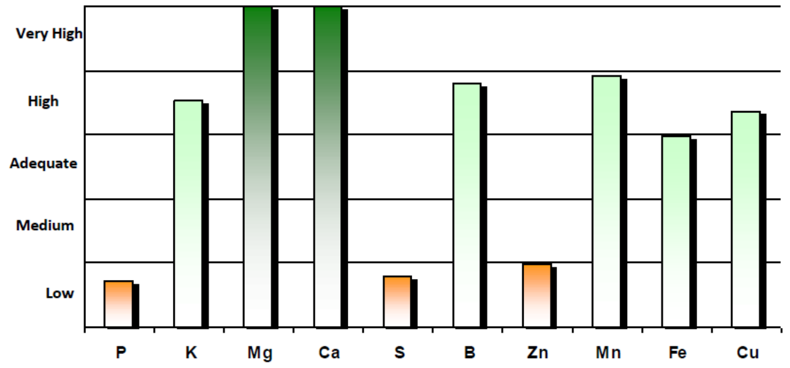
Which one is more important?

Customer: 65829	Sample ID: 1292	
LSU AG CENTER M.D. RASEL PRAVEJ 212A MACON RIDGE ROAD WINNSBORO, LA 71295 UNITED STATES	Grower: RASEL PARVEJ Farm ID: RASEL PARVEJ Field ID: Lab Number: 870214SM Layer ID:	Received: 8/19/2021 Processed: 8/23/2021

Test Method: Mehlich III — Soil Laboratory Data (ppm) — Target pH 6.5

P Phosphorus	K Potassium	Mg Magnesium	Ca Calcium	Soil pH	Buffer pH SMP	S Sulfur	B Boron	Zn Zinc	Mn Manganese	Fe Iron	Cu Copper
14.5	189 H	17 VH	4646 VH	7.8	7.45	10 L	1.2 H	1.95 L	193 H	99.5 A	4.1 H
Al Aluminum	**Na** Sodium	**NO3-N** Nitrate-N	**NH4** Ammonia	**Soluble Salts**	**Organic Matter**	**ENR**	**Mo** Molybdenum	**Ni** Nickel	**BiCarbs**		
	20.5	ppm	ppm	mmhos/cm	1.23 %	12.5	ppm	ppm	meq/L		

Soil Analysis Ratings

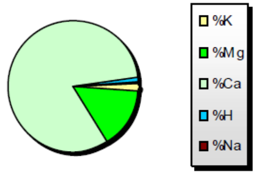


Cation Exchange Capacity	28.5	meq/100g

Base Saturation

K: 1.7 %	Mg: 15.1 %
Ca: [illegible] %	H: 1.4 %
Na: 0.3 %	

Base Saturation

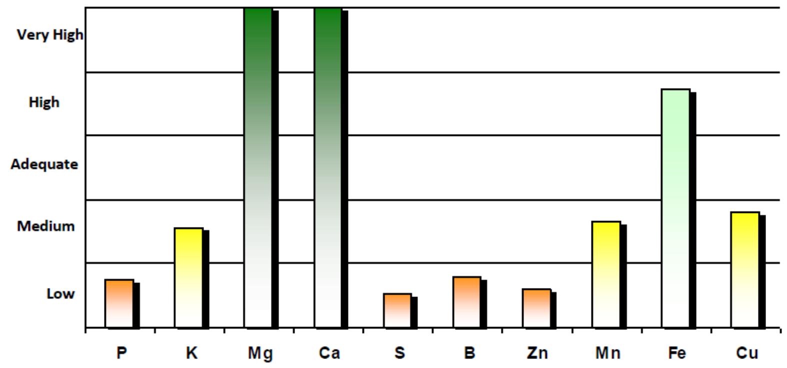


Customer: 65829	Sample ID: 1346	
LSU AG CENTER M.D. RASEL PRAVEJ 212A MACON RIDGE ROAD WINNSBORO, LA 71295 UNITED STATES	Grower: RASEL PARVEJ Farm ID: RASEL PARVEJ Field ID: Lab Number: 870231SM Layer ID:	Received: 8/19/2021 Processed: 8/23/2021

Test Method: Mehlich III — Soil Laboratory Data (ppm) — Target pH 6.5

P Phosphorus	K Potassium	Mg Magnesium	Ca Calcium	Soil pH	Buffer pH SMP	S Sulfur	B Boron	Zn Zinc	Mn Manganese	Fe Iron	Cu Copper
15	91 M	97 VH	1094 VH	6.1	7.30	6.5 L	0.4 L	1.2 L	25 M	172 H	1.4 M
Al Aluminum	**Na** Sodium	**NO3-N** Nitrate-N	**NH4** Ammonia	**Soluble Salts**	**Organic Matter**	**ENR**	**Mo** Molybdenum	**Ni** Nickel	**BiCarbs**		
	20.5	ppm	ppm	mmhos/cm	0.59 %	6	ppm	ppm	meq/L		

Soil Analysis Ratings

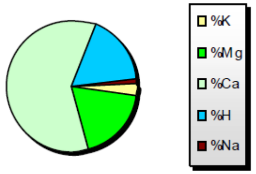


Cation Exchange Capacity	9.0	meq/100g

Base Saturation

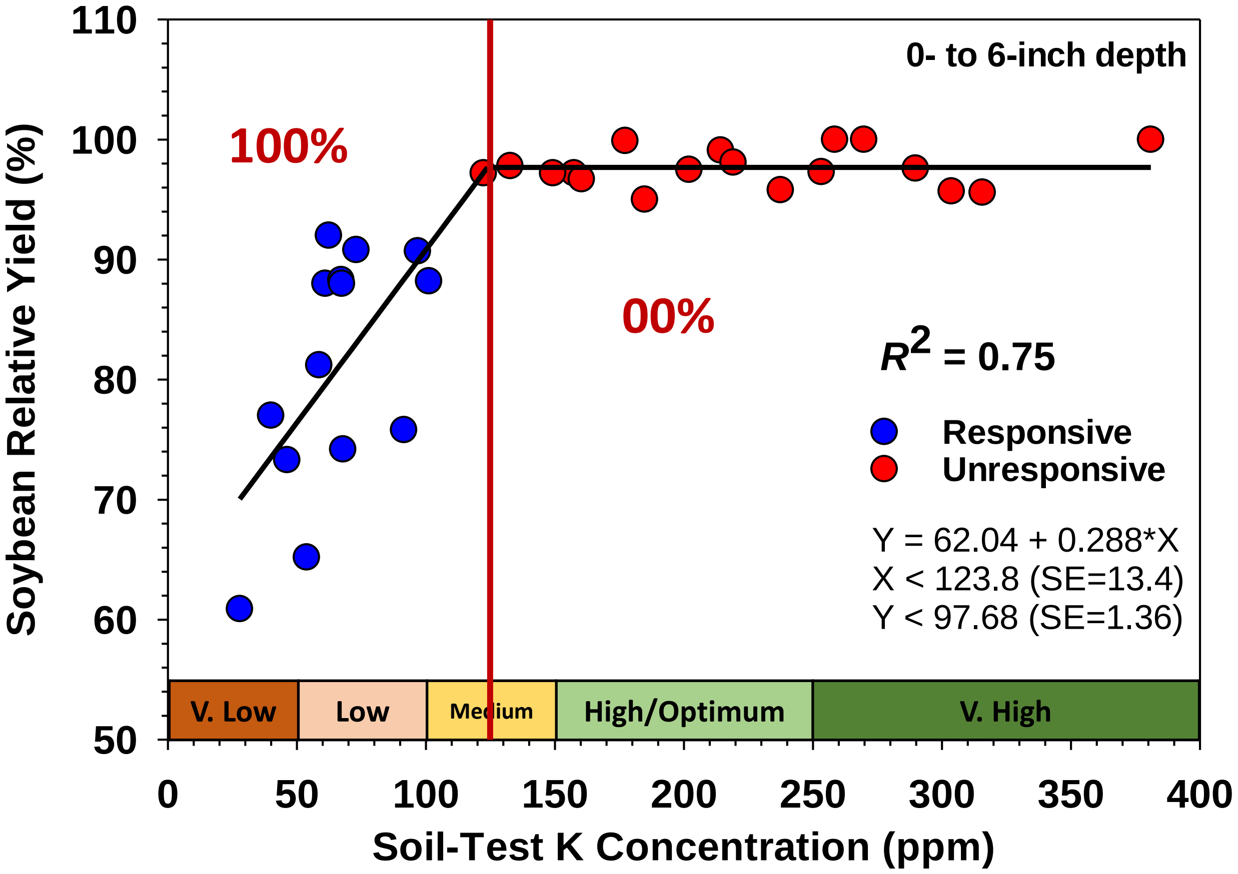
K: 2.6 %	Mg: 18.2 %
Ca: [illegible] %	H: 17.7 %
Na: 1.0 %	

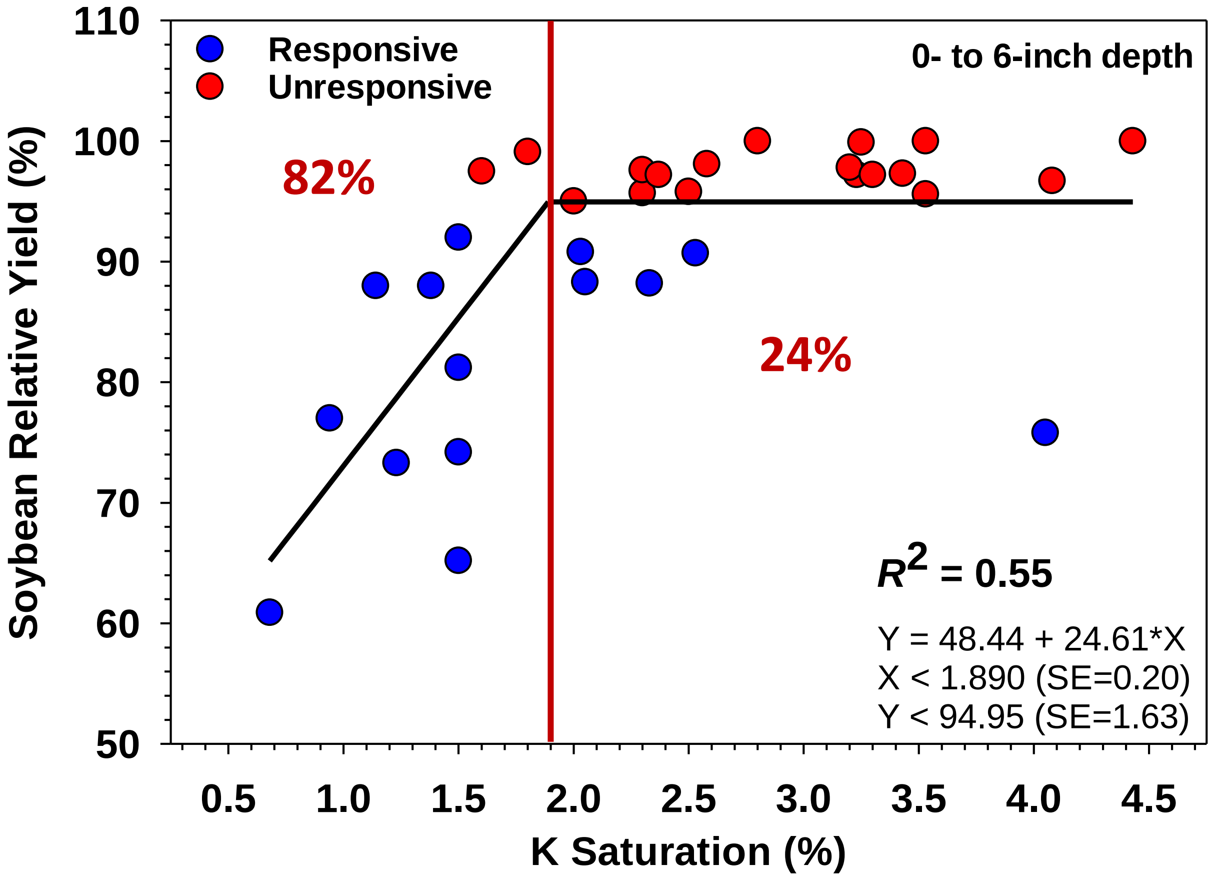
Base Saturation



Soil-Test K Concentration vs. K Saturation

Unfertilized-K Yield





Q3. Can we fertilize in-season P & K and recover yield losses?

Photo: Gerson Drescher

P deficiency

K deficiency

Low P & K soils with no deficiency symptom – Hidden Hunger

Tissue Sampling

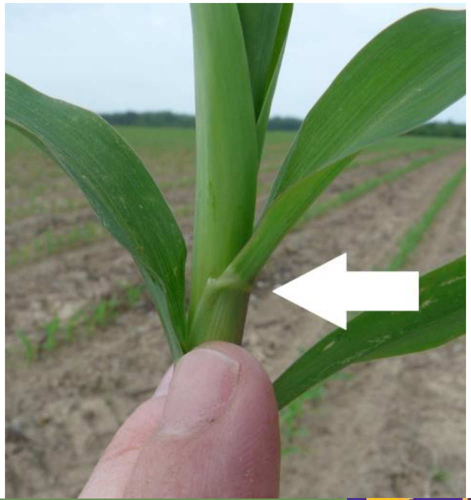
Collect 15 – 20 uppermost recently mature leaves

Soybean

Full bloom (R2) stage

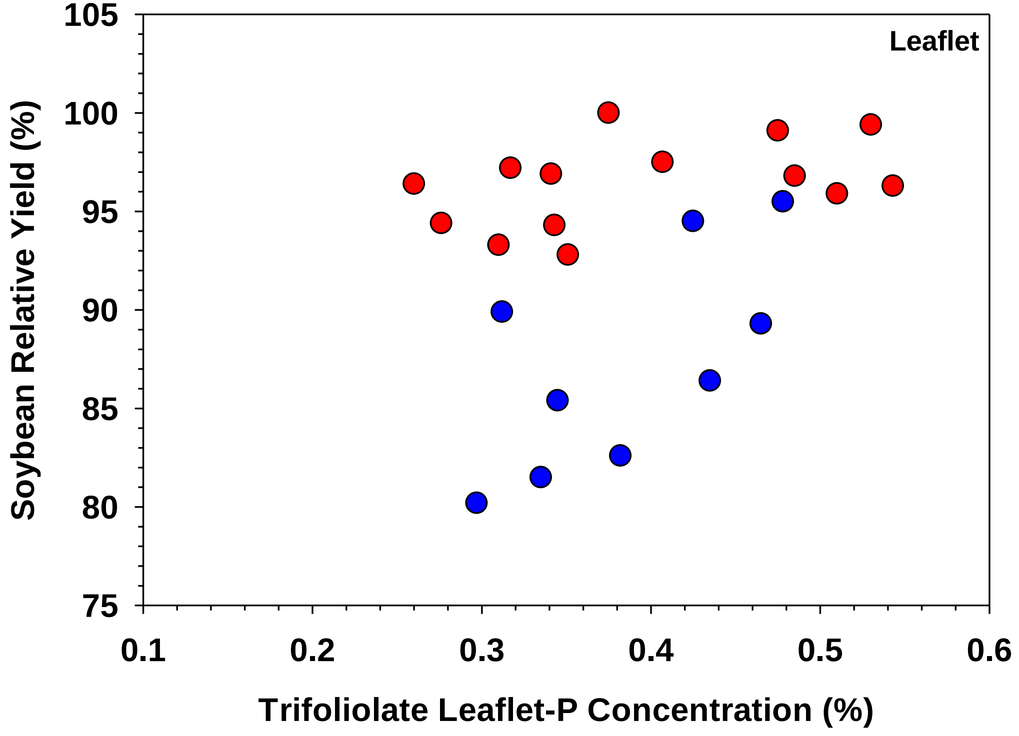
Corn

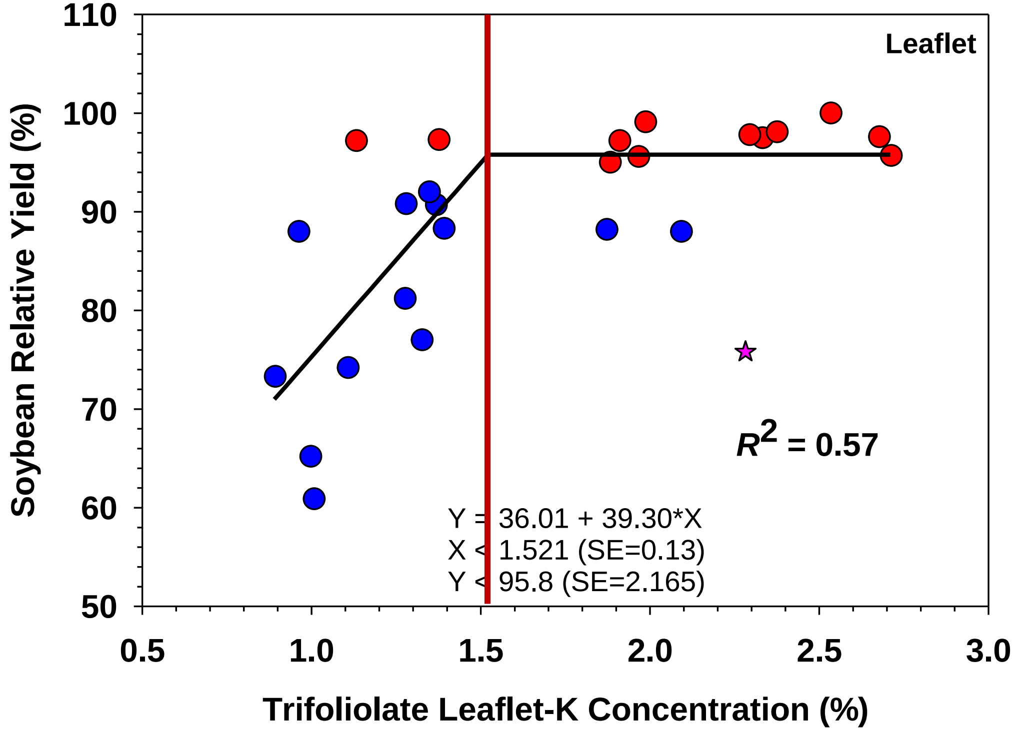
V10-12 (pre-tassel) stage

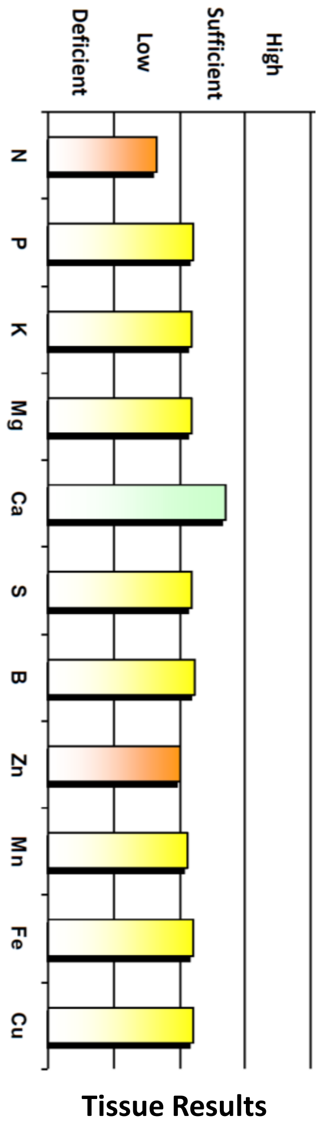


Critical Tissue P & K Concentrations in Soybean & Corn

Full bloom (R2) stage

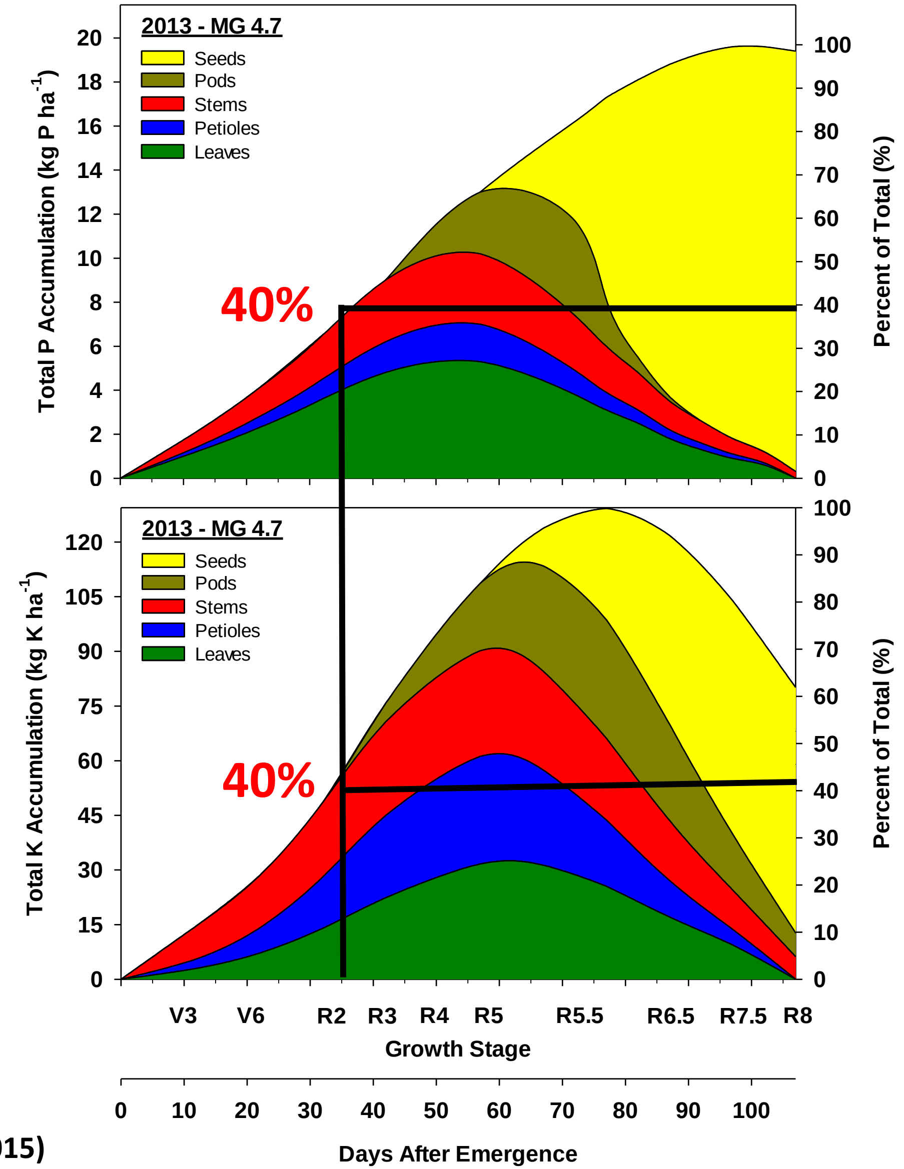




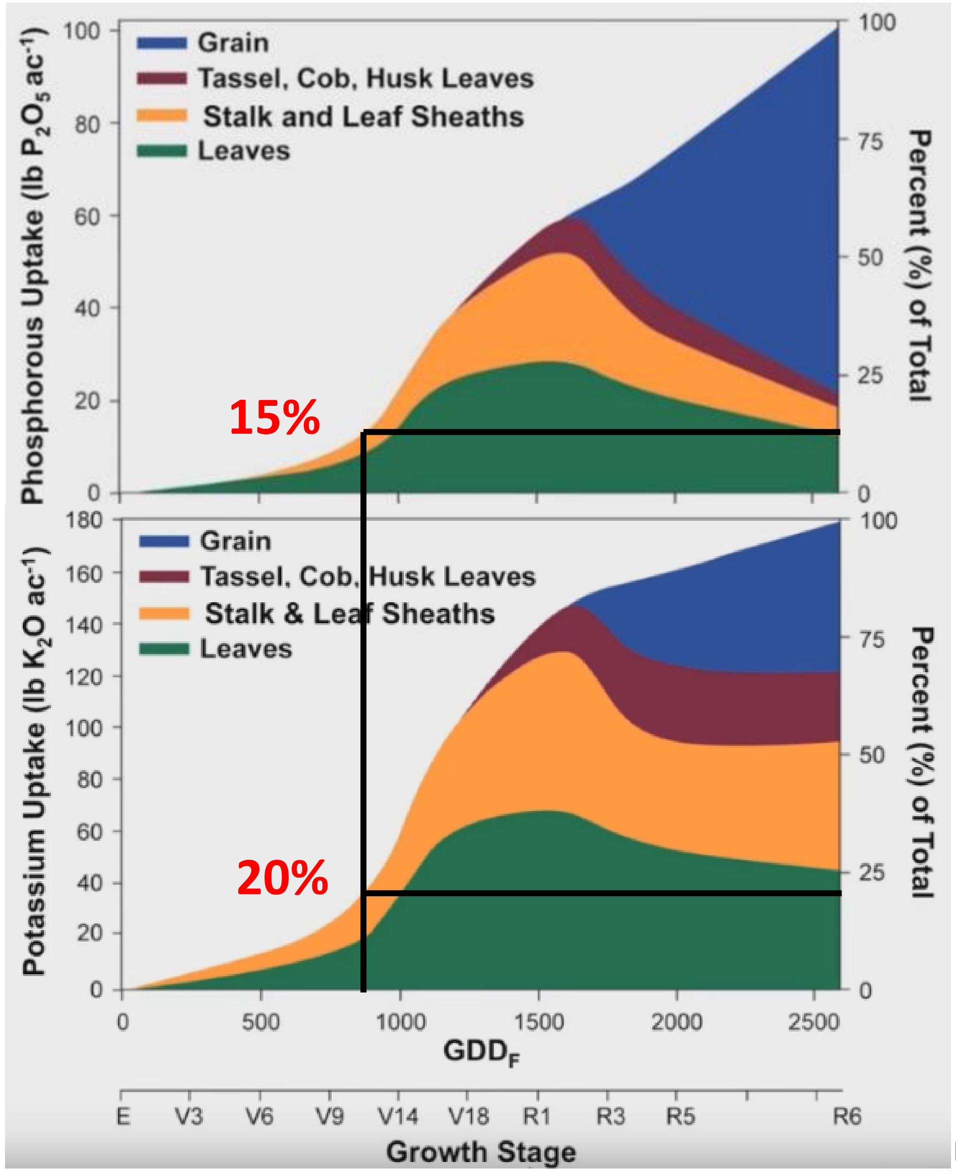


- ✓ Soybean leaf-K concentration at full bloom (R2) stage: **1.5 – 1.9% K**
- ✓ Corn leaf-K concentration at V10-12 (pre-tassel) stage: **1.5 – 2.0% K**

Deficiency Management: Seasonal P & K Uptake by Soybean and Corn



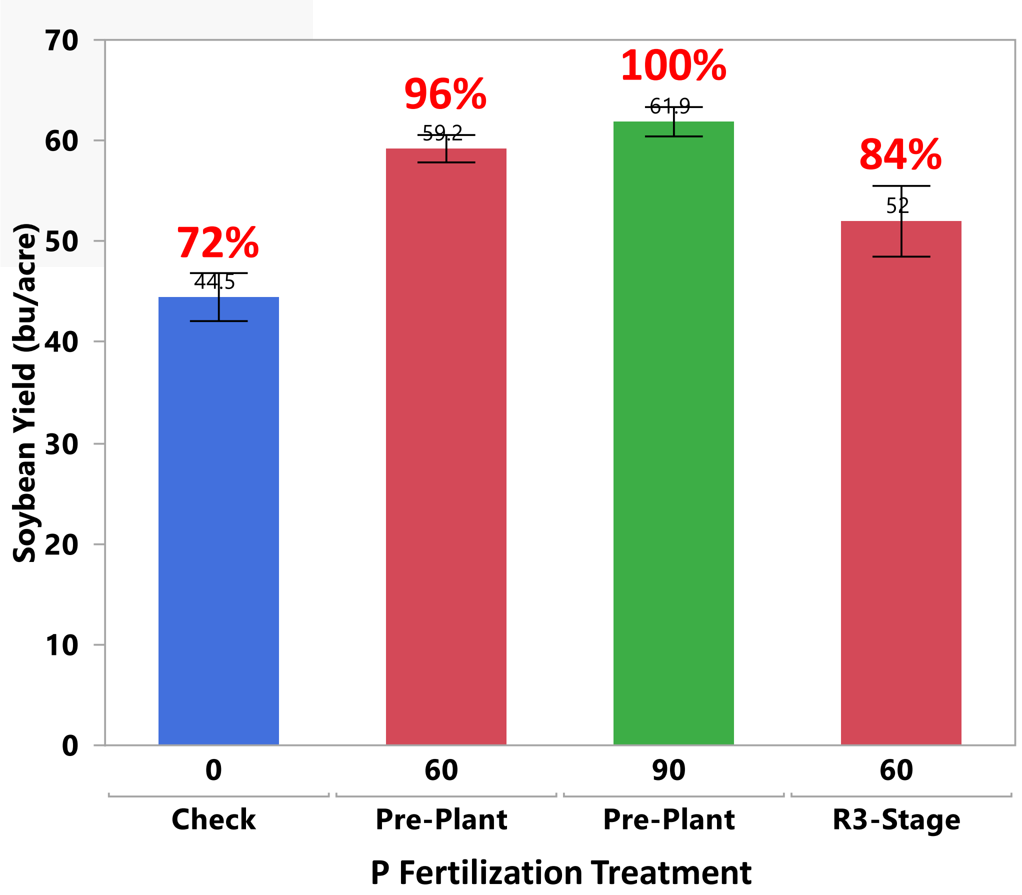
Parvej et al. (2015)



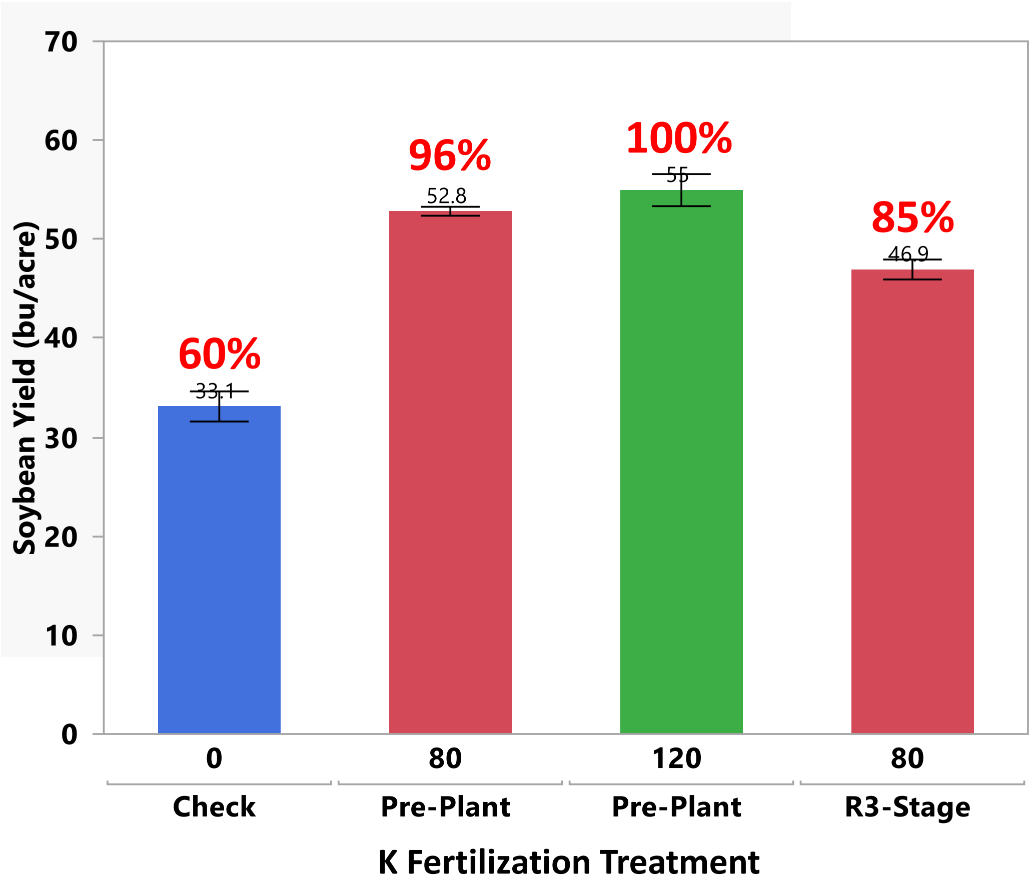
Bender et al. (2013)

In-Season P & K Deficiency Management in Soybean

P study: silty clay loam (soil-P: 19 ppm)

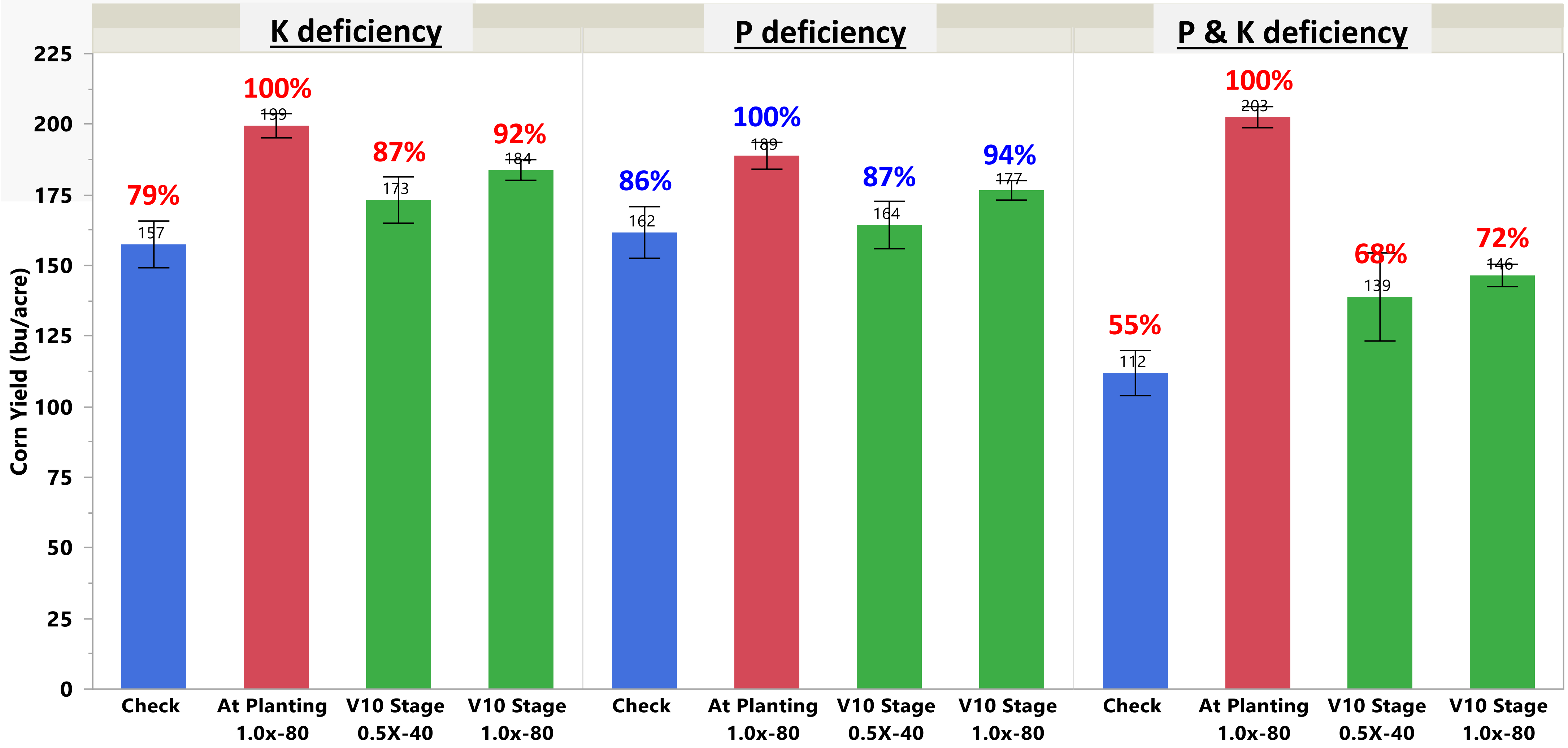


K study: silt loam (soil-K: 28 ppm)

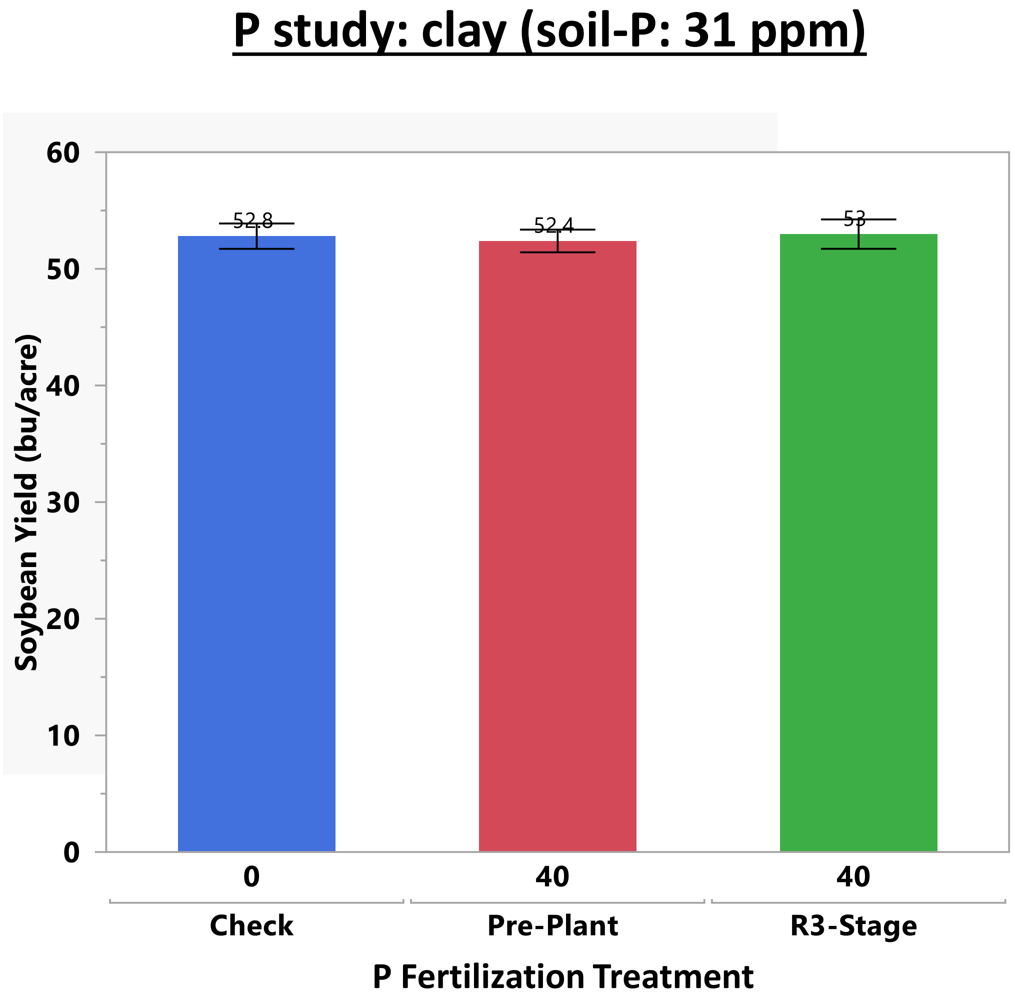


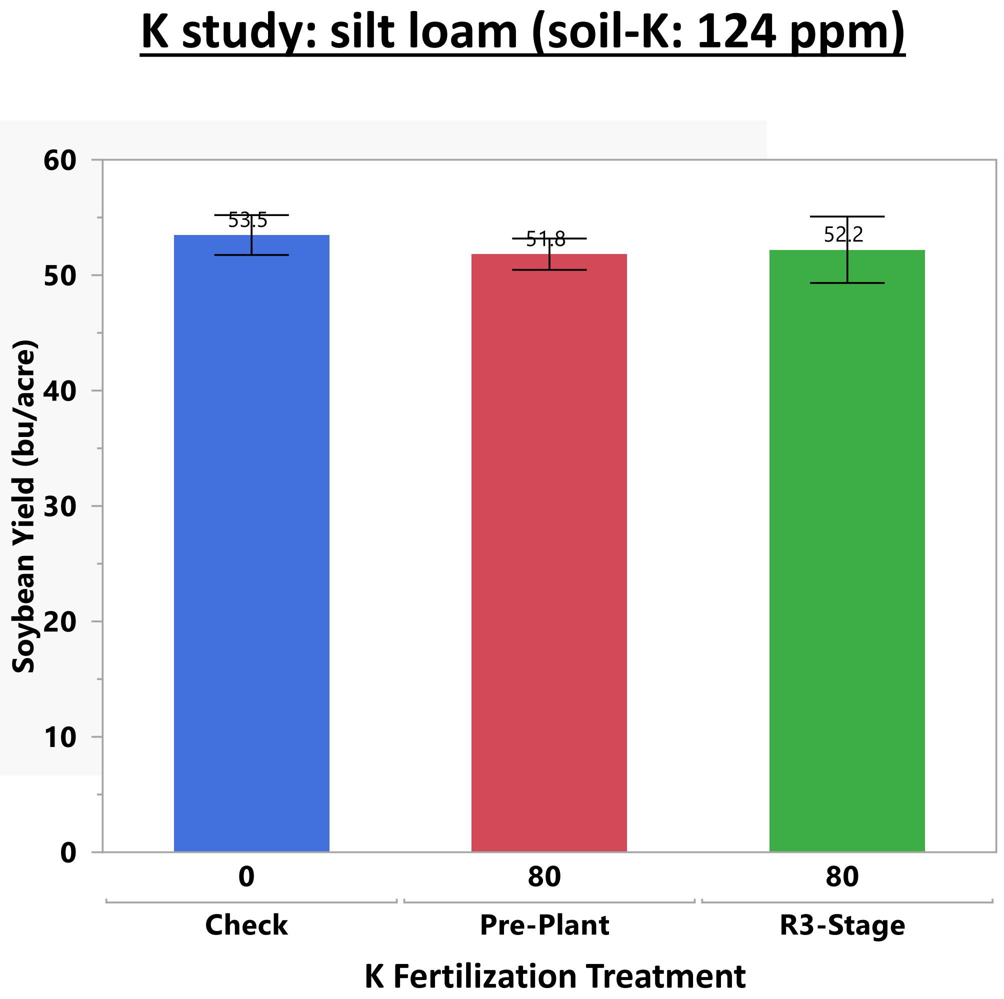
In-Season P & K Deficiency Management in Corn

Soil-P: 16 ppm & Soil-K: 60 ppm



In-Season P & K Application in Medium Testing Soils





In-Season Fertilization Consideration

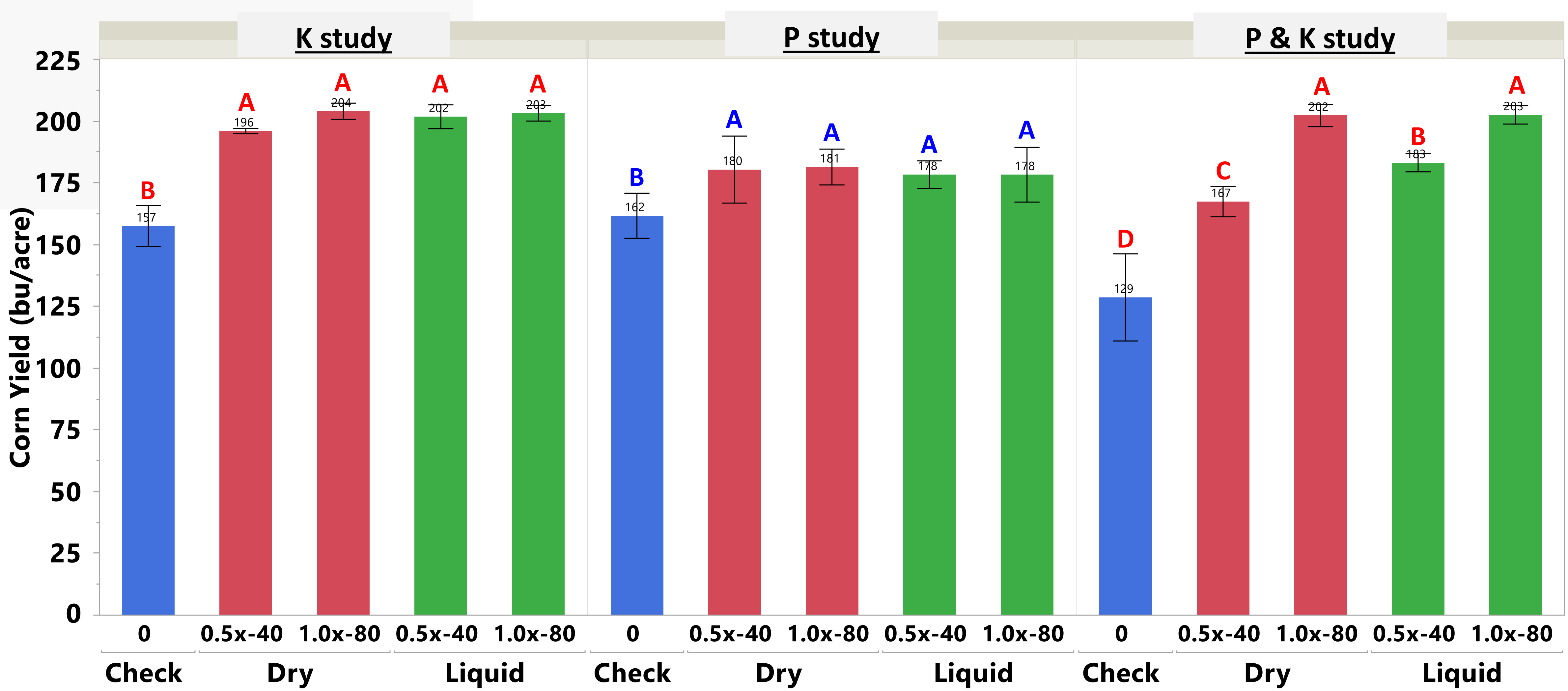
- ✓ Fields with soil-test P and/or K conc. below critical levels.
- ✓ Fields haven’t received any pre-plant P & K fertilization.
- ✓ Make sure no drought stress during the growing season.
- ✓ Collect leaf tissue sample at the specific growth stage.
  - Soybean leaf-K at full bloom (R2) stage: **1.5 – 1.9% K**
  - Corn leaf-K at V10-12 (pre-tassel) stage: **1.5 – 2.0% K**
- ✓ **Recommendations: Top-dress at least 60 lb K2O/acre (100 lb Potash) and/or 46 lb P2O5/acre (100 lb TSP).**

Q5. Is liquid P & K fertilizer better than dry fertilizer?

- **Year & Location: 2021**
  - ✓ Macon Ridge and Northeast Research Station
  - ✓ Silt Loam Soils
- **Dry source:**
  - ✓ P: TSP (0-46-0)
  - ✓ K: Potash (0-0-60)
- **Liquid source:**
  - ✓ P: Ammonium PolyPhosphate (11-37-0)
  - ✓ K: Nachurs K-Fuel (0-0-24)
- **Fertilizer Rate:**
  - ✓ Half-Rate (0.5x): 40 lb P_2O_5 and K_2O per acre
  - ✓ Full-Rate (1.0x): 80 lb P_2O_5 and K_2O per acre

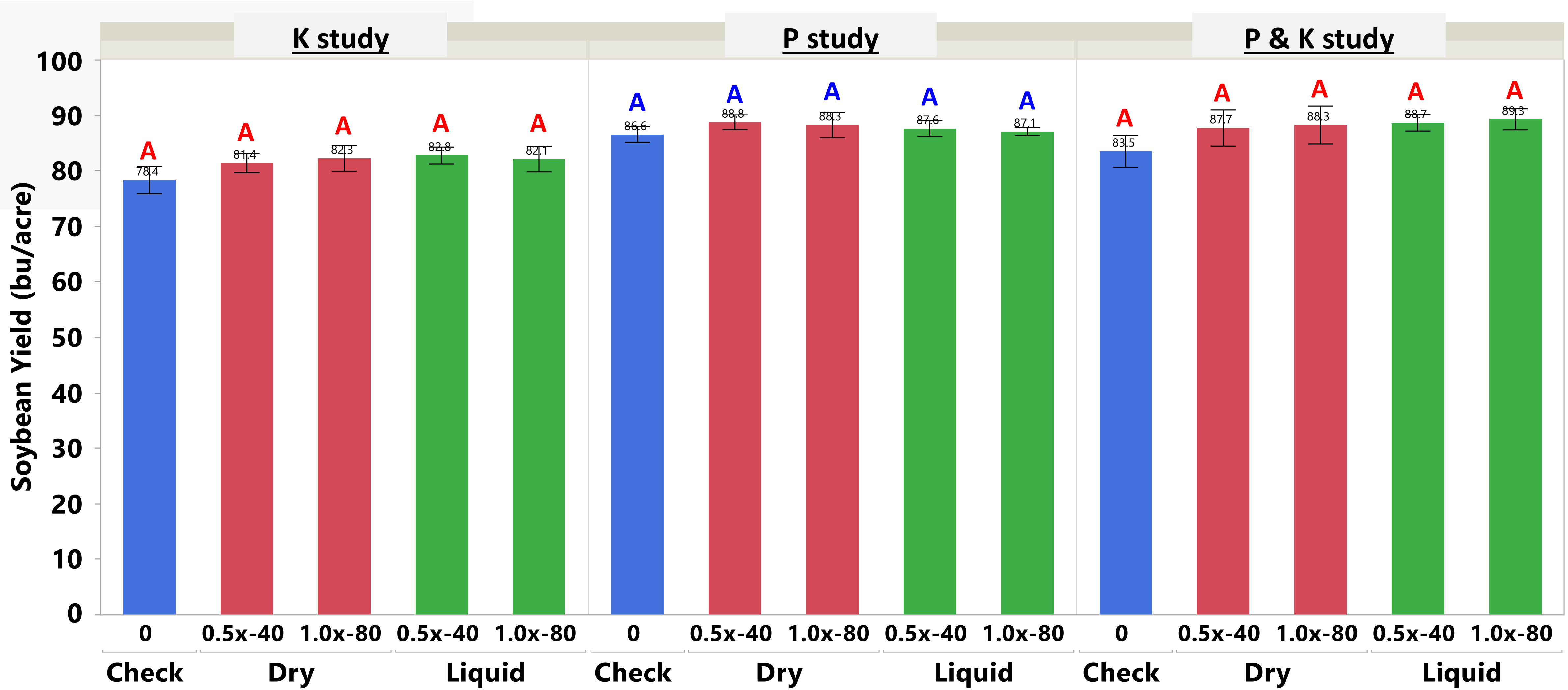
Dry vs. Liquid P & K Fertilizers in Corn

Soil-P: 16 ppm & Soil-K: 60 ppm



Dry vs. Liquid P & K Fertilizers in Soybean

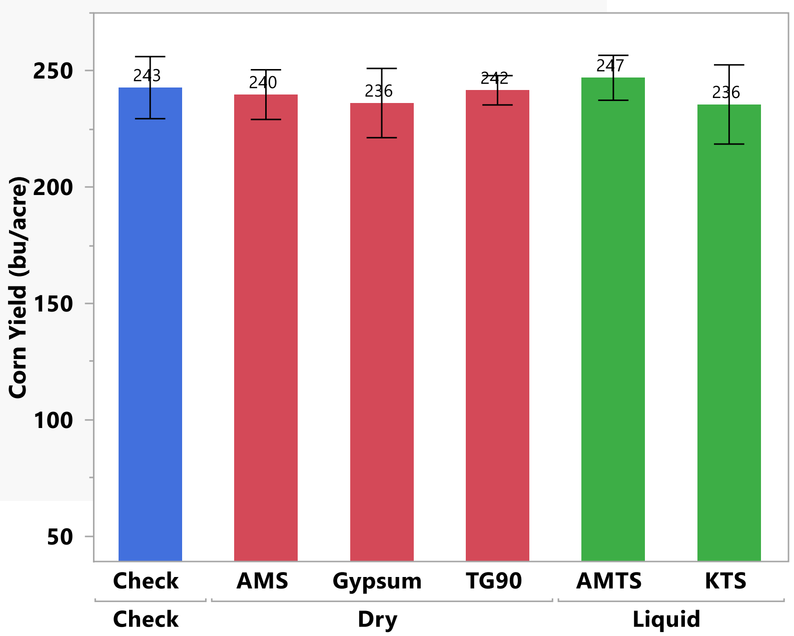
Soil-P: 26 ppm & Soil-K: 112 ppm



Dry vs. Liquid S Fertilizers

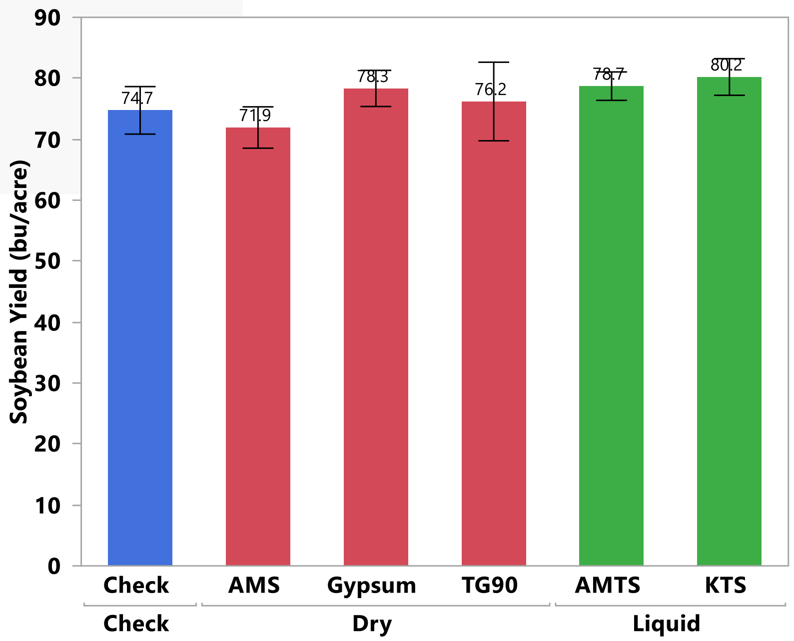
Corn

Soil-S: 9 ppm (0-6-inch) & 20 ppm (6-12-inch)



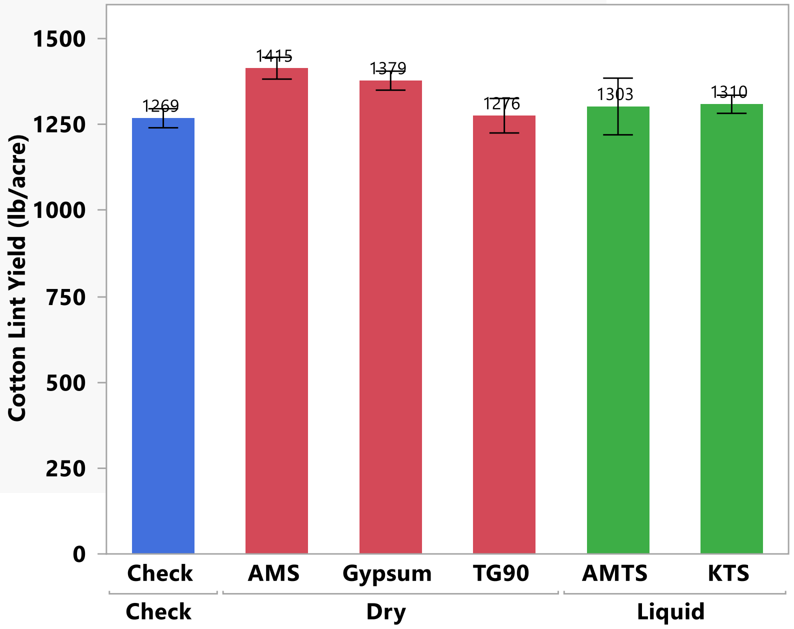
Soybean

Soil-S: 9 ppm (0-6-inch) & 13 ppm (6-12-inch)



Cotton

Soil-S: 15 ppm (0-6-inch)

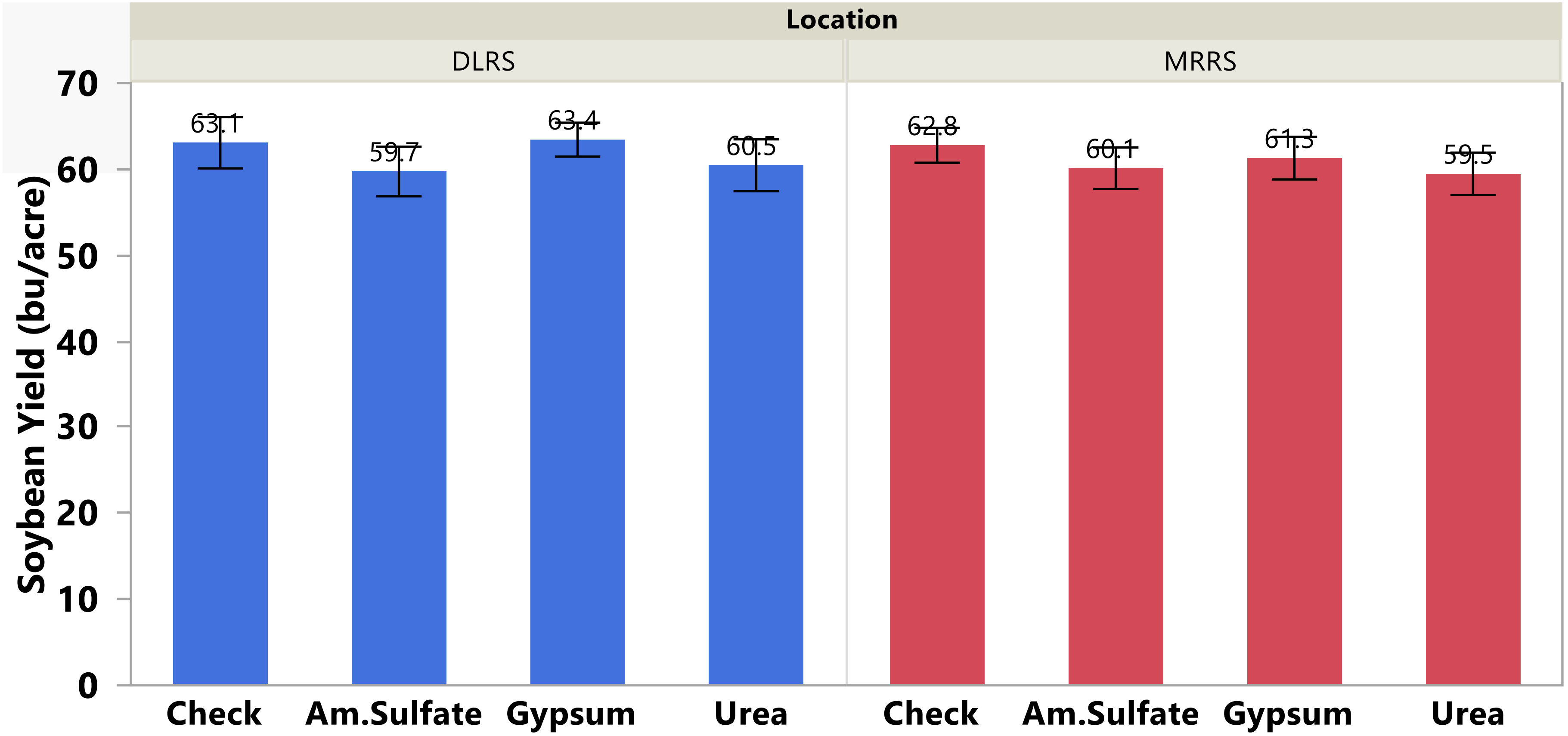


How good is our soil-test-based S recommendations?

What S source should we use for soybean?

Silty clay loam (Soil-S: 11 ppm)

Silt loam (Soil-S: 13 ppm)



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Take home messages .....

1. N fertilizer needs to be applied in at least 2 splits for optimizing yield with reduced N rate.
2. Tissue testing from the V10 to pre-tassel stages can accurately predict pre-tassel N needs.
3. Spring fertilization of P and K is equal or better than fall fertilization in Low testing soils.
4. Invest money on soil testing rather than fertilizing field without knowing the yield response.
5. In-season fertilization on low testing fields is a viable option to correct P & K deficiencies.
6. Spend money on core fertilizers rather than different soil amendments/unknown products.
7. Ammonium sulfate may not be a good option for fulfilling sulfur requirements in soybean.

Thank You

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