DIVISION OF AGRICULTURE
RESEARCH & EXTENSION
University of Arkansas System

SOIL FERTILITY

Fine-Tuning Corn Phosphorus and Potassium Recommendations - Arkansas & FRST efforts

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Soil testing background

UADA Soil Testing and Research Lab

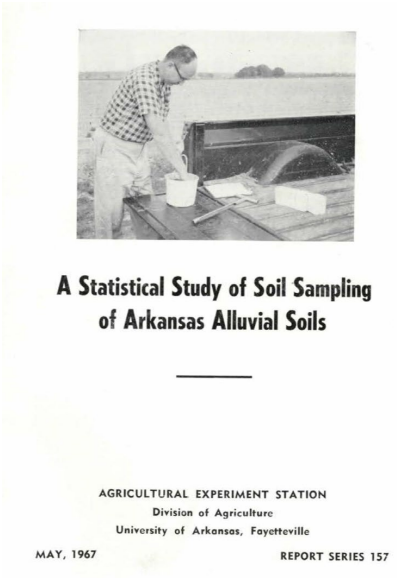
Mission: provide analytical, educational, and research information to clientele concerning the responsible management of nutrients found in the soil, inorganic fertilizers, and organic amendments to optimize land productivity and preserve environmental and natural resources.

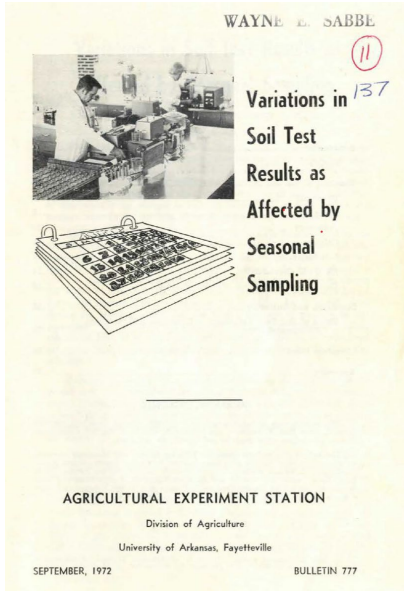
Director of Lab

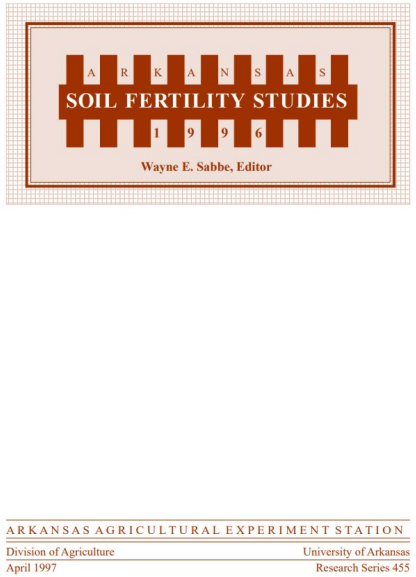
- D.R.P. Bartholomew **1945**-1949
- Dr. R.L. Beacher 1949-1966
- Dr. W.E. Sabbe 1966-1999
- Dr. J.L. Barrentine (interim) 1999-2001
- Dr. N.A. Slaton 2001-present

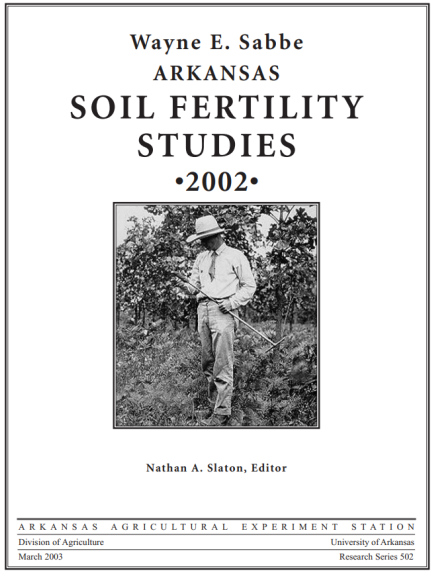
Crop & Soil Scientist

- Drs. Wells, Keough, Norman, Wilson, Jr., Gilmour, Oosterhuis, Roberts, etc...









Fine-tuning fertilizer-P and -K recommendations

Arkansas fertilizer-K recommendations

	Soil-test level	Very Low	Low	Medium	Optimum	Above Optimum
	Fertilizer rate (lb K_2O/acre)					
✓	Soybean	160	120	75	50	0
✓	Rice	120	90	60	0	0
?	Corn	160	120	70	50	0
?	Cotton	140	95	60	40	0

Arkansas fertilizer-P recommendations

	Soil-test level	Very Low	Low	Medium	Optimum	Above Optimum
	Fertilizer rate (lb P_2O_5/acre)					
✓	Soybean	90	70	50	0	0
✓	Rice pH >6.5	70	60	50	0	0
✓	Rice pH <6.5	50	40	30	0	0
?	Corn	120	90	70	0	0
?	Cotton	90	70	50	0	0

- **How accurate are our fertilizer rate recommendations for corn?**

Recommendations are dated and/or no yield data to support current fertilizer P and K recommendations…

Summarizing past research data for metanalysis/correlation and calibration …

Fine-tune recommendations (soil-test thresholds for P) and identify where additional research needs to be performed (both P and K)…

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Crop, Forage & Turfgrass Management

CROP MANAGEMENT

Corn yield response to phosphorus and potassium fertilization in Arkansas

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Assigned to Associate Editor D. Arnall

Abstract
Phosphorus and potassium are key nutrients for plant physiological processes and are required in large amounts for adequate corn (*Zea mays* L.) production. Corn is a major row crop, and up-to-date soil test-based fertilizer recommendations are required to enhance production and profitability. The results from 32 P and 42 K field trials evaluating irrigated corn response to fertilizer P and K rates were used to (i) correlate corn's relative yield response to Mehlich mine the frequency and magnitude of the yield resp calibrate fertilizer P and K rates to soil test P and K. els identified 36 parts per million (ppm) P (r^2 = .6 (r^2 = .36, P < .0001) as the Mehlich-3 soil test P ar 95% of maximum yield without fertilization. Additio with P < 15 and > 35 ppm and K < 60 and > 120 pp in the analyses and improve our understanding of cor ization. The current thresholds defining soil test K lev soil K availability and corn's response to K fertilizat definitions should be modified to improve the accura for irrigated corn. The calibration results suggest the rates are greater than needed to maximize yield.

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Agronomy Journal

ARTICLE

Crop Economics, Production, and Management

Profit-maximizing potassium fertilizer recommendations for corn and cotton

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Assigned to Associate Editor Nathan DeLay.

Funding information
Soil Test Review Board

Abstract
Whereas K fertilization is necessary to maximize corn (*Zea mays* L.) and cotton (*Gossypium hirsutum* L.) yields in soils with sub-optimum K availability, maximizing yield is rarely profit-maximizing. Estimating the tradeoff between yield and fertilizer cost using current soil-building and/or yield-maximizing rate recommendations vs. profit-maximizing fertilizer-K rates (KR*) provides insights for producers. Thirty-nine and 24 fertilizer-K rate trials were used to estimate respective corn and cotton yield response based on soil-K availability (SK). Using a field's SK, yield potential, yield response to fertilizer-K, crop price, and fertilizer-K cost, KR* were calculated over the past 10 yr. Averaging over that period, using KR* at SK of 75 and 60 mg K kg^{-1} (a) reduced fertilizer-K rate by 10 and 38 kg K ha^{-1}, respectively, (b) decreased yield by 53 and 32 kg ha^{-1}, respectively, and (c) increased profitability by US$1.75 and $34.24 ha^{-1}, respectively, in comparison to current recommendations for corn. At SK of 75 and 110 mg K kg^{-1}, cotton profitability at KR* vs. current recommendations rose by $11.54 to $25.95 ha^{-1}, respectively, using 36 and 101 kg K ha^{-1} more fertilizer, respectively, which led to 27 and 73 kg ha^{-1} greater yield, respectively. As with prior studies for rice (*Oryza sativa* L.) and soybean [*Glycine max* (L.) Merr.], corn results suggest using less fertilizer than currently recommended, whereas for cotton, strong yield response to fertilizer-K and relatively high crop price justified KR* that were above currently recommended rates. A spreadsheet-based decision tool is online to offer this insight to producers and crop consultants.

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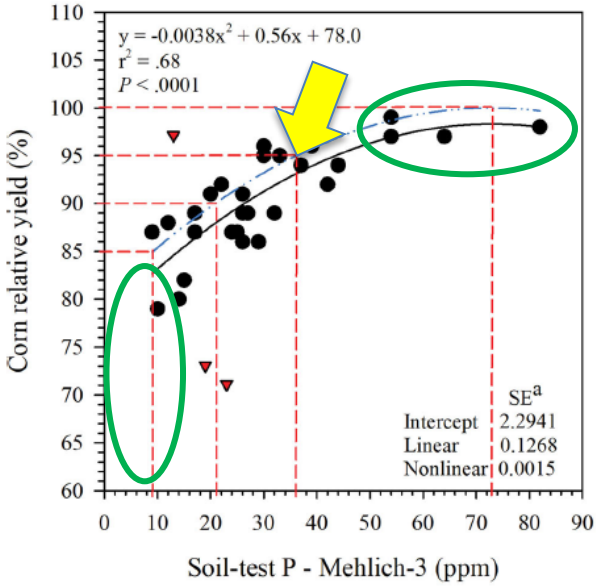
No change in P rates, but new STP interpretation:

TABLE 1. Interpretation of soil-nutrient concentration ranges and soil test levels of surface soil samples for most row crops and forages. The interpretation for vegetable crops and other plants may vary.

Soil Test Level	Expected Yield Potential†	Mehlich-3 Nutrient Concentrations								
		P	K [Most Crops]	K [Turf Codes]	Ca‡	Mg‡	SO_4-S‡	Mn‡	Cu‡	Zn
		mg/kg (or ppm)								
Very Low§	<65%	<16	<61	<21						<1.6
Low§	65 - 85%	16 - 25	61 - 90	21 - 40	≤400	≤30	≤10	<40	<1.0	1.6 - 3.0
Medium§	85 - 95%	26 - 35	91 - 130	41 - 60						3.1 - 4.0
Optimum	100%	36 - 50	131 - 175	61 - 100						4.0 - 8.0
Above Optimum (High)	100%	>50	>175	>100						>8.0

†Expected yield potential without fertilization.
‡Recommendations are not provided for these nutrients. The listed values represent general guidelines for interpretation.
§The soil test levels of "Very Low," "Low" and "Medium" are considered "Sub-Optimum" levels.

- **Research need:** target specific soils for additional P & K response trials to improve our correlation and calibration database (Arkansas & FRST)



New corn soil-test P categories (2022)

Phosphorus (P) and Potassium (K):

P_2O_5 Recommendation

Yield Goal (bu/ac)	-----Soil Test P (ppm)-----				
	≤8	9-16	17-35	36-50	≥51
	----- lbs of P_2O_5 per acre -----				
125	80	60	40	0	0
150	100	70	50	0	0
175	120	80	60	0	0
≥ 200	120	90	70	0	0

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Crop Forage & Turfgrass Mgmt. 2021; 7:e20120.
https://doi.org/10.1002/cft2.20120

https://www.uaex.uada.edu/farm-ranch/crops-commercial-horticulture/corn/2022-Arkansas-Corn-Quick-Facts.pdf

Soil Phosphorus Calibration

- **2023 - Corn Yield Response to Phosphorus Fertilizer Rate & Source**
- **2024 & 2025 - Corn Yield Response to Phosphorus Fertilizer Rate, Source, & Time**

- **Objective:** to facilitate the correlation and calibration of fertilizer-P and ensure the proper nutrient management techniques are implemented for furrow-irrigated corn

Research approach

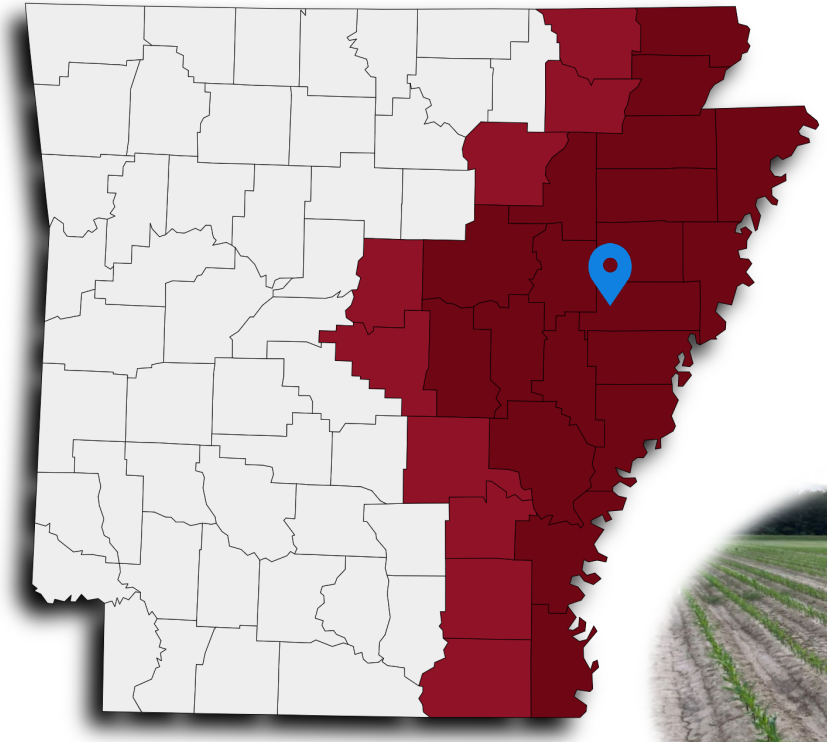
Trial Information

- Location: PTRS, Colt, AR
- P-rates 23 & 24: 0, 40, 80, 120, 160 lb P_2O_5/ac
- P-rates 25: 0, 30, 60, 90, 120 lb P_2O_5/ac
- Plots: 4 rows wide (raised beds), 30 ft long
- Soil: silt loam soils (Calloway & Calhoun)
- Very Low or Low STP
- High soil pH (>7.0)
- Furrow-irrigated

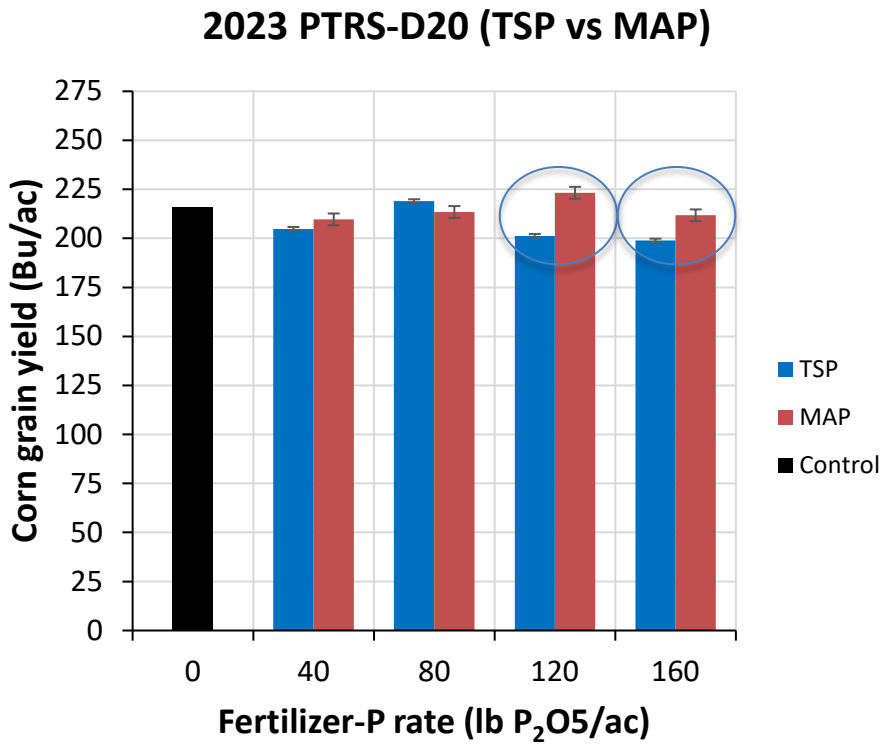
Measurements:

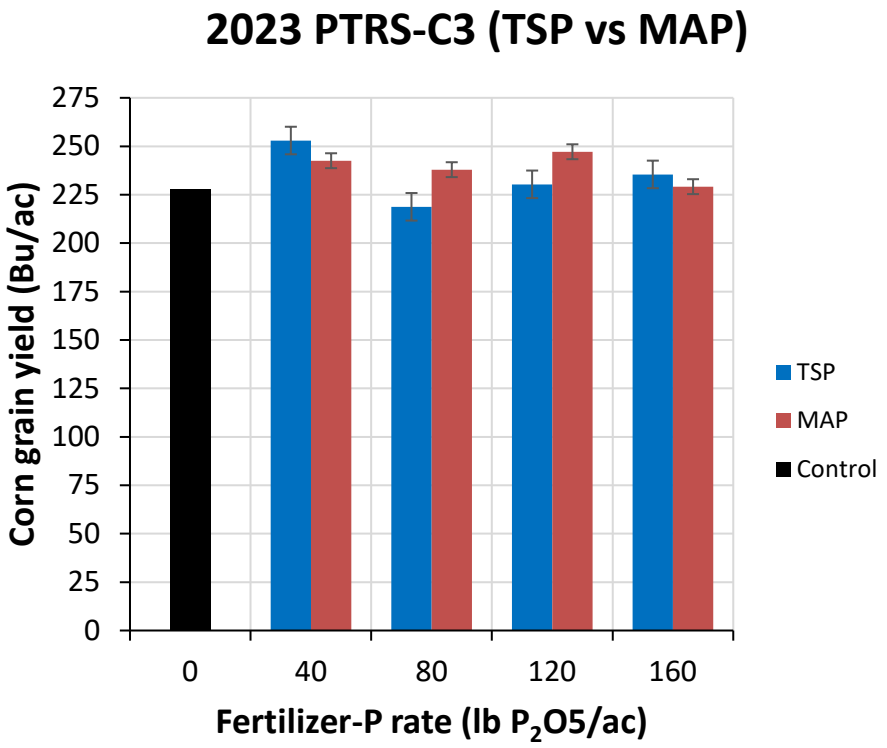
- Tissue nutrient concentrations at V6 and VT
- **Corn grain yield at maturity**

Corn P response trials location
2023, 2024, & 2025



2023 Growing season

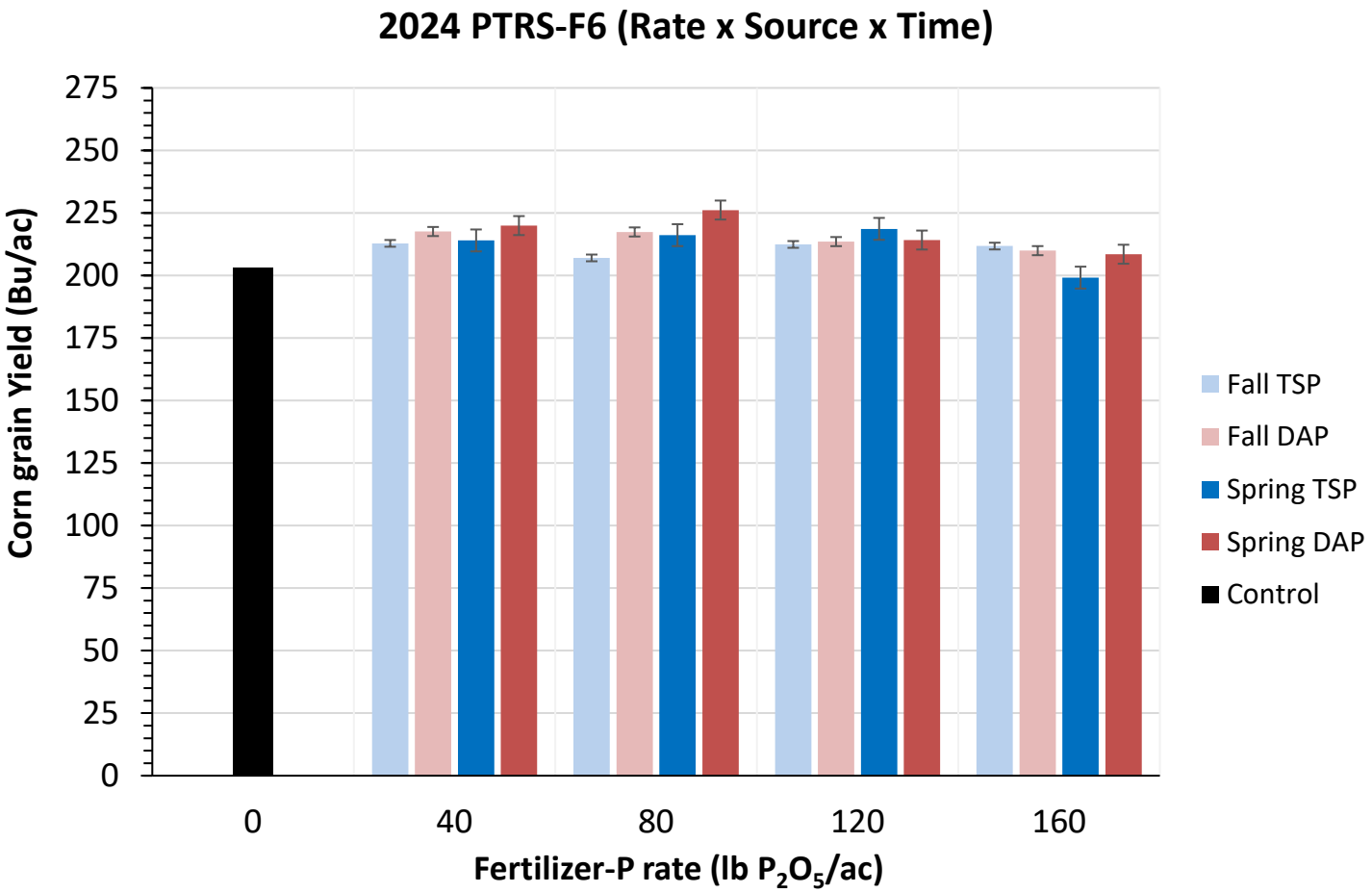


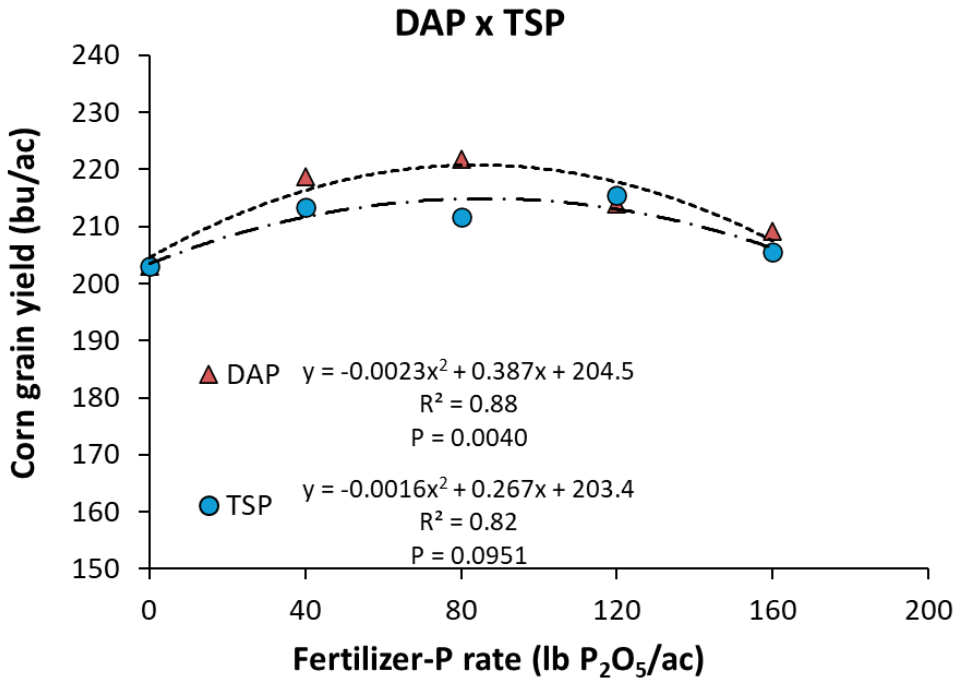


M3P = 6.6 ppm P (Very Low STP)
pH = 6.9
Source: *MAP > TSP
Rate: ns

M3P = 13 ppm P (Low STP)
pH = 7.5
Source: ns
Rate: ns

2024 Growing season



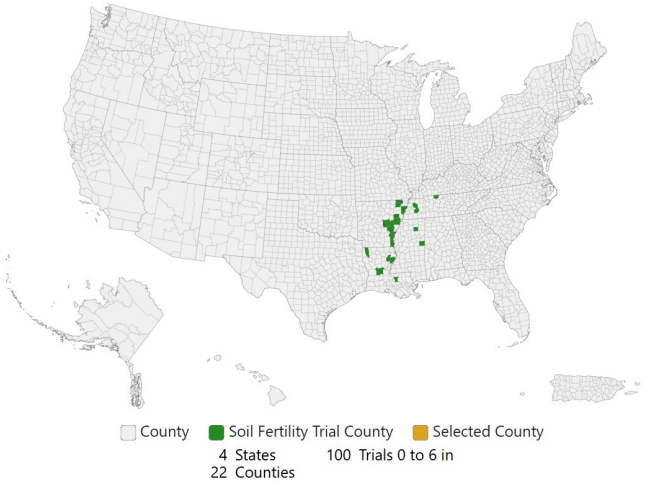


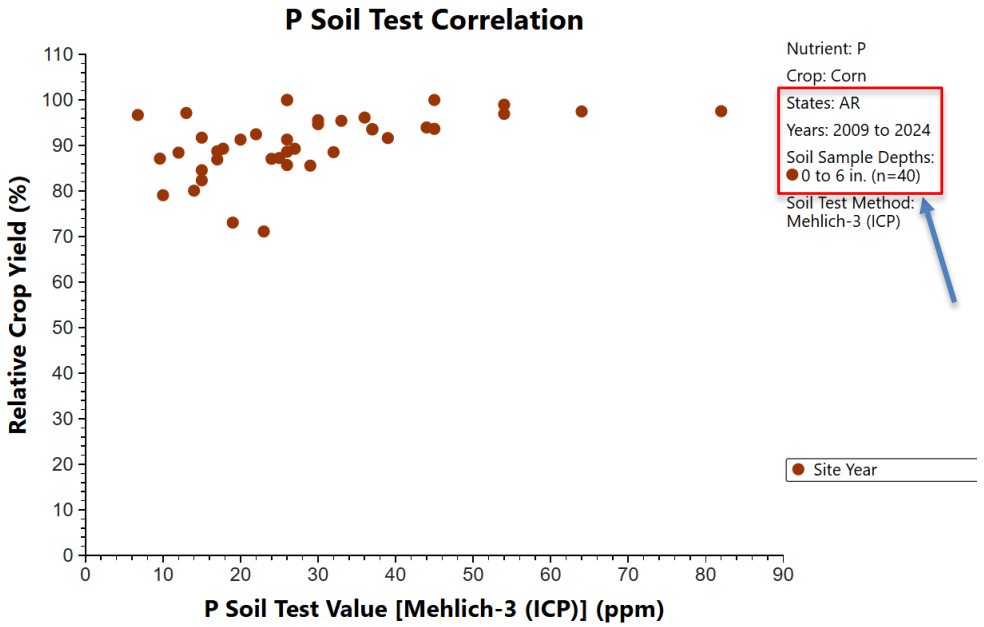
- M3P = 17 ppm (Low STP)
- pH = 7.1
- Calloway silt loam

Rate: *
Source: *
Time: ns

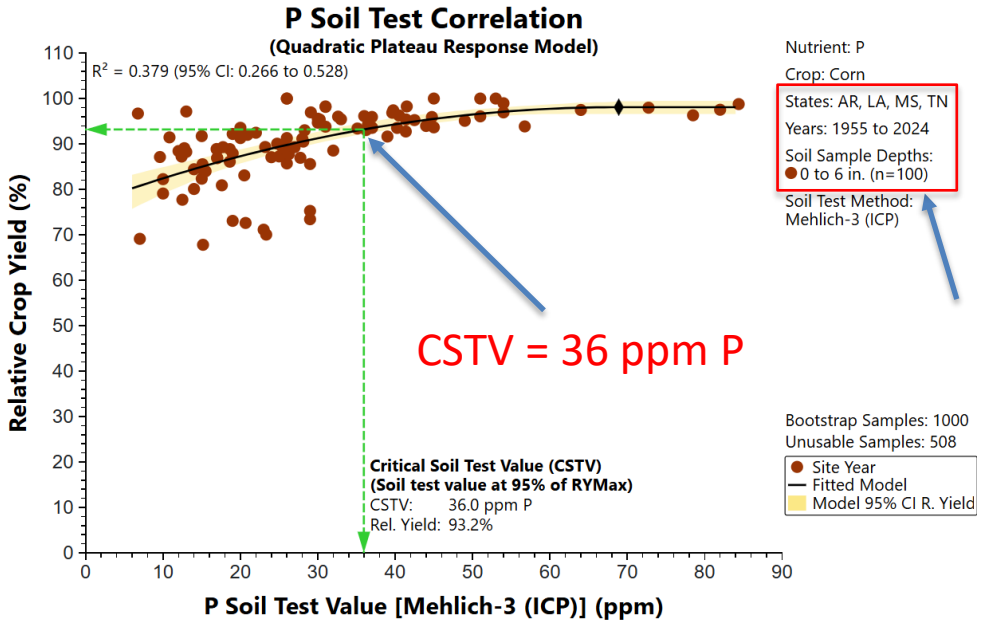
Summary corn P trials

- Sites were not very responsive to P fertilization, despite low P availability
- Slight advantage of MAP/DAP over TSP, but not consistent across fertilizer-P rates & site-years
- No difference between Fall and Spring P application
- Improving FRST database:





(Note: FRST was unable to calculate an acceptable correlation from the selected data. This may occur because of poor data distribution, lack of positive crop yield response to fertilization, or several other factors.)



Estimated Model Parameters Using Bootstrapping

Parameter	Value	Description
STVJP(♦)	68.9	Nutrient soil test value (ppm) where relative crop yield is constant. (Join Point)
RYMax(♦)	98.1	Relative crop yield (%) maximum value. (Plateau relative crop yield)
Int	76.6	Relative crop yield (%) at nutrient soil test value of 0

Thank you!

Questions?

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SOIL TESTING

FRST FERTILIZER RECOMMENDATION SUPPORT TOOL

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