DIVISION OF AGRICULTURE
RESEARCH & EXTENSION
University of Arkansas System

SOIL FERTILITY

# Fine-Tunning Potassium Recommendations for Cotton in Arkansas


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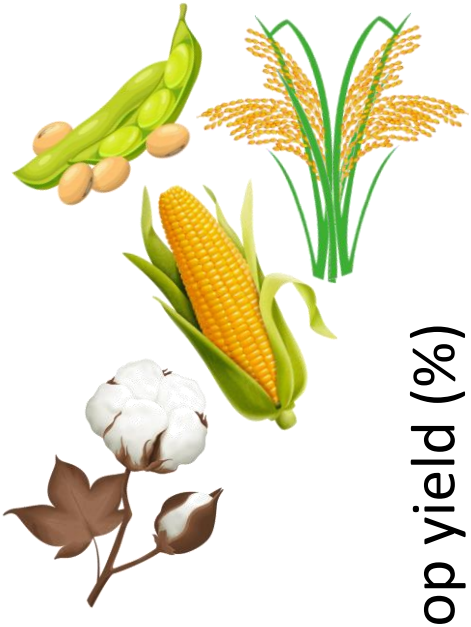
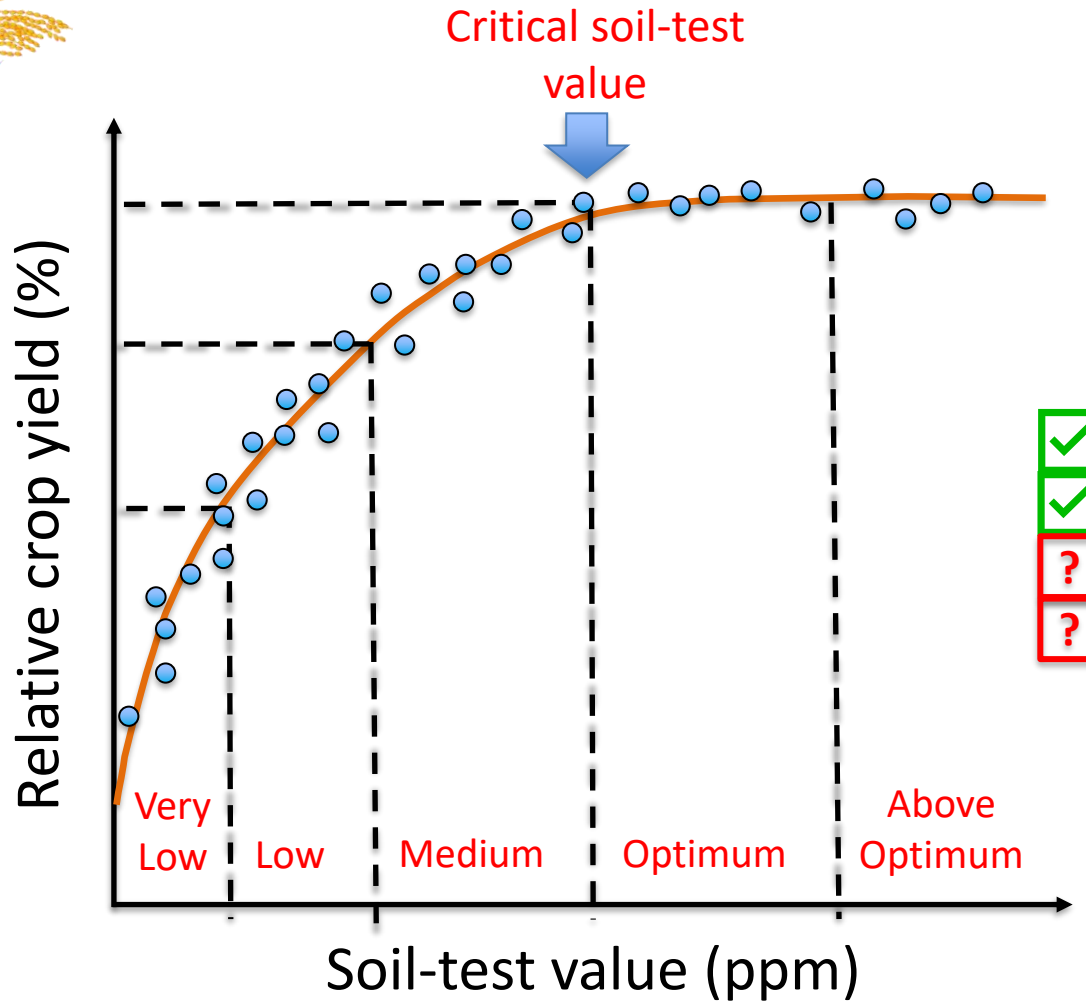
FRST monthly meeting, July 12, 2024

# Fine-tuning fertilizer-P and -K recommendations



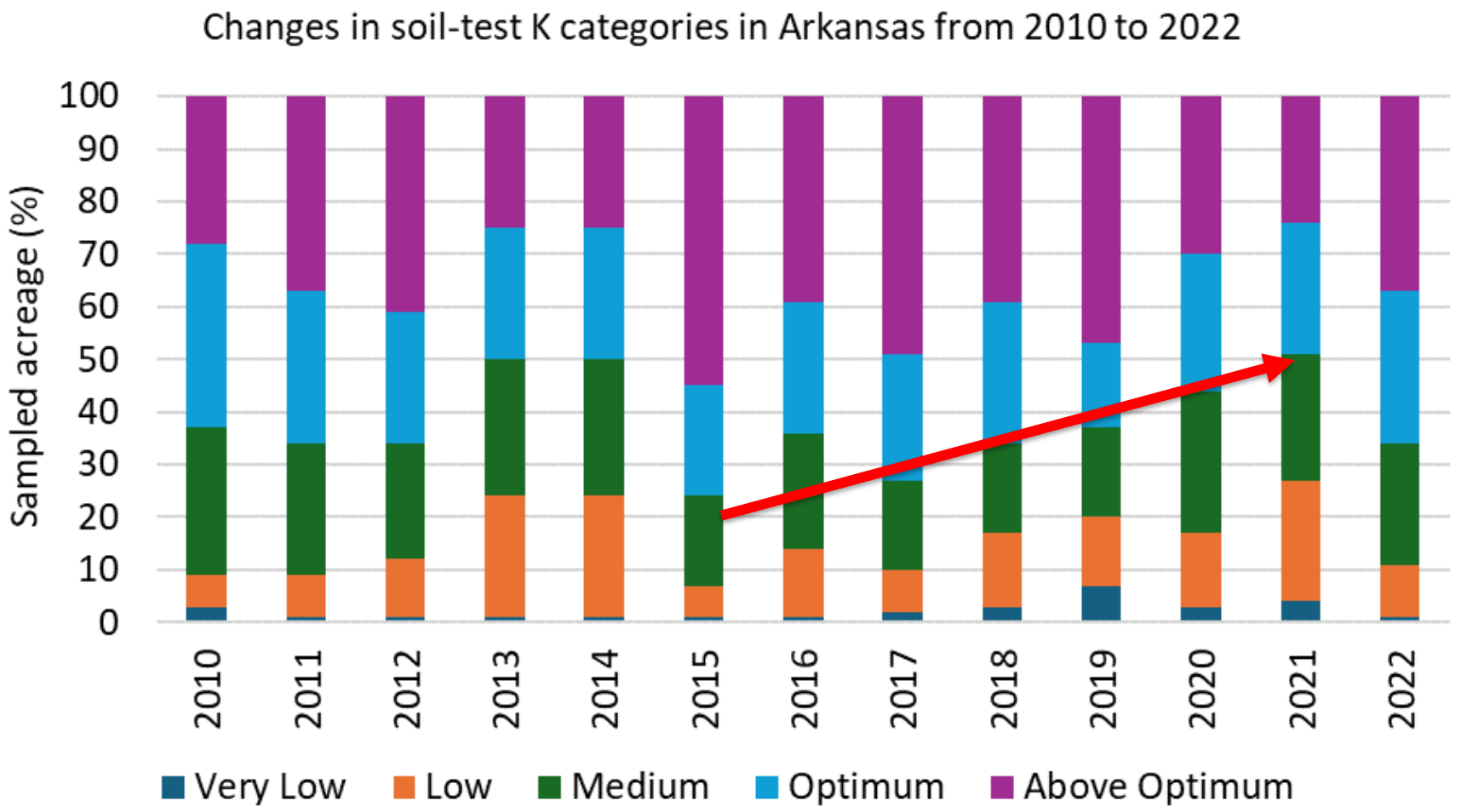

***Arkansas fertilizer-K recommendations***

| | 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 |

**How accurate are our fertilizer-K recommendations???**

**Dated and/or no yield data to support the recommendation…**

# Summary of Mehlich-3 soil-test K of soil samples submitted to the UADA Marianna Soil Test Lab between 2010-2022 where cotton was the previous crop




**Trend of increasing cotton acreage with soil-test K below-optimum, where a positive yield response to fertilization may occur!**



Source: adapted from DeLong et al. (Multiple: 2012 - 2024).

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Agronomy Journal

ORIGINAL ARTICLE

Agronomy, Soils, and Environmental Quality

## Potassium losses in runoff from cotton production fields

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Assigned to Associate Editor Olga Walsh.

**Funding information**
Arkansas Soil Test Review Board; Natural Resources Conservation Service; The Fertilizer Institute

**Abstract**

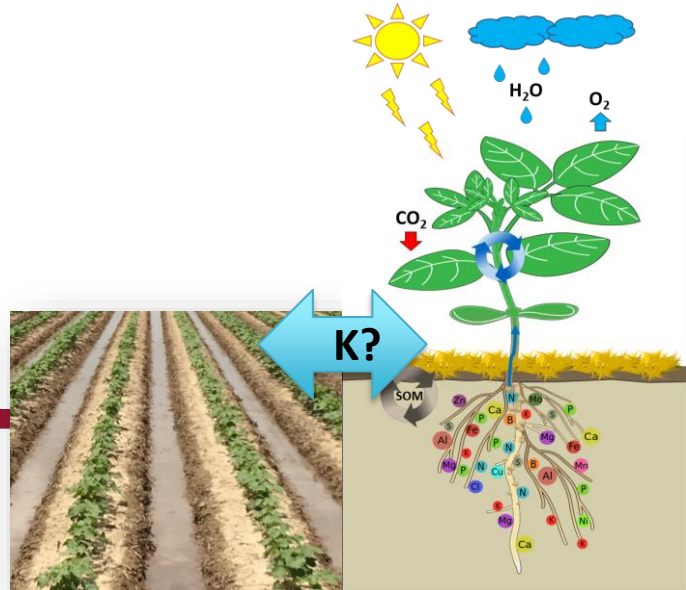
Potassium (K) loss in runoff represents a potential financial concern since fertilizer-K is routinely applied to sustain optimal crop K nutrition and yield potential. Our research objectives were to quantify and characterize the soluble-K loss in runoff from fields used for continuous cotton (*Gossypium hirsutum* L.) production while determining if the time of the year (growing season vs. nongrowing season), type of hydrological event (irrigation vs. rainfall), and cover crops influence K loss in runoff. Field-scale, edge-of-field monitoring of runoff water and its soluble-K concentration was performed on 10 site years in southeastern Arkansas across three production seasons. The mean K loss in surface runoff per event was 0.98 kg $ha^{-1}$ across all sites and events ($n = 304$). The relationship between loss of K mass to runoff volume was positive and significantly correlated ($p < 0.0001$) when both variables were transformed by the natural logarithm. K loss during the growing season was significantly higher ($p < 0.001$) in the cotton growing season whereas K loss resulting from runoff events generated by either irrigation or rainfall was not significant. Additionally, losses from fields with cover crops were significantly larger ($p < -0.05$) than from fields without covers. Cumulative annual-K loss, between annual fertilizer-K applications, averaged 32.2 kg K $ha^{-1}$ across all site years representing a significant economic loss to replace the lost K with fertilizer. This study illustrates the increased

# Challenges for effective K management in cotton

- Increasing reports of K deficiency
- K loss by runoff

## Monitor plant nutrition

- Scouting
- Tissue-K analysis?
  - Inconsistent data in the literature…
  - Different critical values reported…
  - What plant tissue? Leaves? Petioles? Both?
  - What growth stage?



# Summarizing past research data for metanalysis/correlation and calibration …


**Fine-tune recommendations and indicate where additional research needs to be performed!**

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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 fertili… 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 ($r^2$ = .68… ($r^2$ = .36, $P$ < .0001) as the Mehlich-3 soil test P an… 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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# Fine-tuning cotton fertilizer-K recommendations

**Fertilizer-K rate and price, and application cost**


**Soil-test K**

**Crop yield and value**

PRC POTASH RATE CALCULATORS 0-0-60

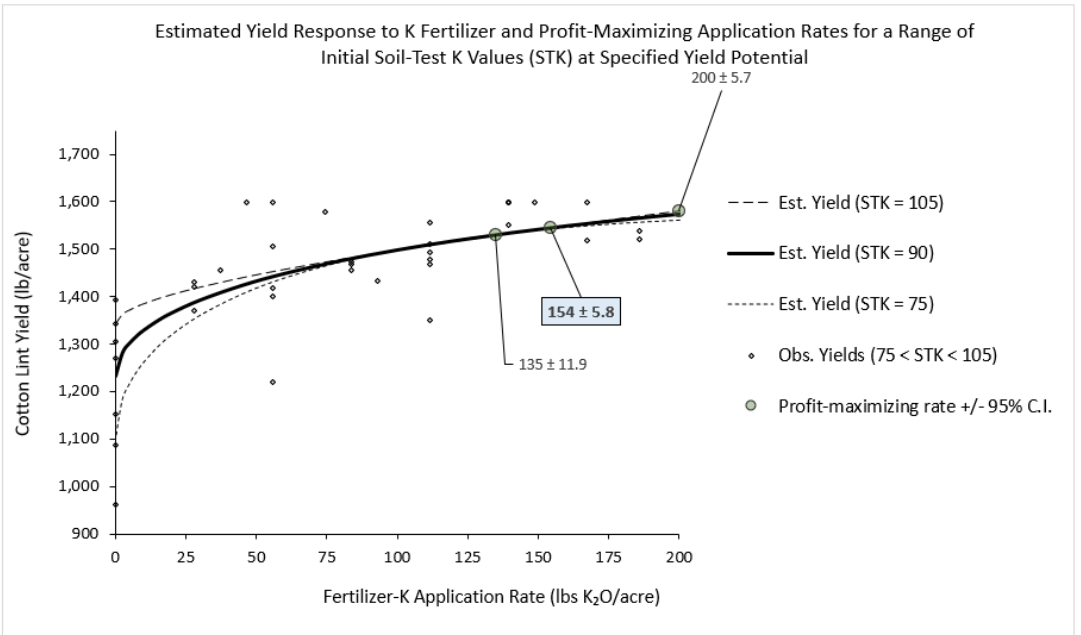
**Decision-support tool to define fertilizer-K rates to maximize profitability!**

**Profit-Maximizing K Rate Calculator for Irrigated Cotton**

as developed by Dr. M. Popp, Dr. N. Slaton, Dr. G. Drescher, K. Oliver and Dr. T. Roberts

PRC POTASH RATE CALCULATORS

| | | | |
|---|---|---|---|
| What is your expected cotton lint price? | 1.00 $/lb | ☐ Metric | Fit to Screen |
| … please be sure you added your gin rebate to your lint price. Average is $0.05/lb of lint | | | |
| What do you expect to pay for muriate of potash fertilizer? | 862 $/ton | 0.72 $/lb of $K_2O$ | |
| What is the cotton lint yield potential of your field? | 1,600 lbs/acre | What is your est. lint turnout? | 38% |
| … given your lint turnout you expect 4211 lbs of seed cotton/acre | | | |
| What is your soil-test K value (STK) and range? | 90 ppm | Soil test range +/- | 15 |
| What is your cost to apply fertilizer (equipment, labor, fuel or custon | 7.50 $/acre | …your rate in lbs of $K_2O$/acre: | 83 |
| Profit change comparing applying at 154.4 lb $K_2O$/acre to no fertilizer: | 194.72 $/acre | Profit-max rate over your rate: | $14.47 |

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SOIL TESTING

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https://doi.org/10.1002/agj2.21205

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PRC POTASH RATE CALCULATORS

# Fine-tuning cotton fertilizer-K recommendations


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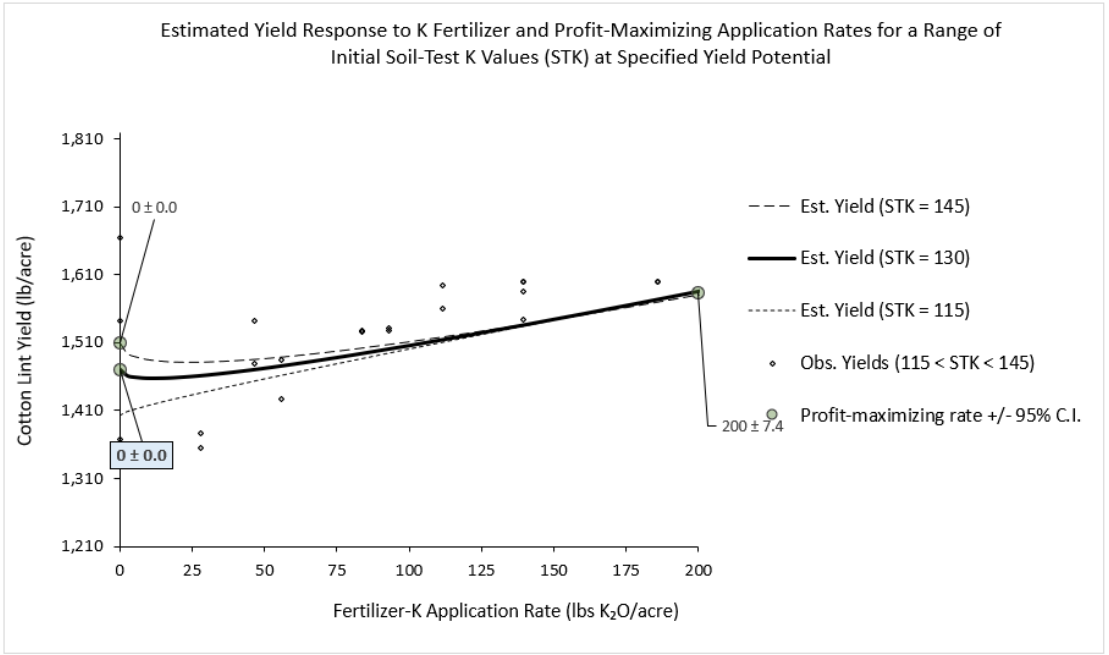
| What is the cotton lint yield potential of your field? | 1,600 lbs/acre | What is your est. lint turnout? | 38% |
| … given your lint turnout you expect 4211 lbs of seed cotton/acre | | | |
| What is your soil-test K value (STK) and range? | 130 ppm | Soil test range +/- | 15 |
| *The response curve turns U shaped for 117 ppm < STK < 177 ppm. Exercise caution when considering rate recommendations above 117 ppm STK.* | | | |
| What is your cost to apply fertilizer (equipment, labor, fuel or custom)? | 7.50 $/acre | …your rate in lbs of $K_2O$/acre: | 53 |
| Profit change comparing applying at 0.0 lb $K_2O$/acre to no fertilizer: | 0.00 $/acre | Profit-max rate over your rate: | $42.12 |

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- **Additional studies are needed to have a more robust database for fertilizer-K correlation and calibration**
- **How can we diagnose a K deficiency or check the adequacy of our nutrient management program?**

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# Cotton Response to Potassium Fertilization in Arkansas

**Objectives:**

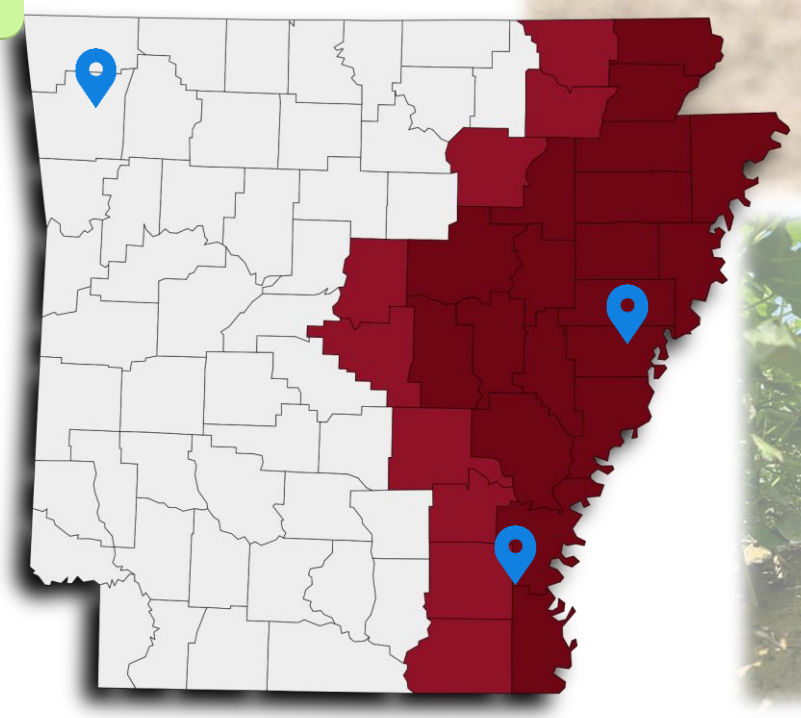
i) to evaluate cotton yield responses to K fertilization and improve the database to calibrate fertilizer-K rates.

ii) to investigate in-season tissue-K dynamics and define critical tissue-K concentrations that maximize corn and cotton yield.

# Fine-tuning Fertilizer-K Rate Recommendations

## Locations

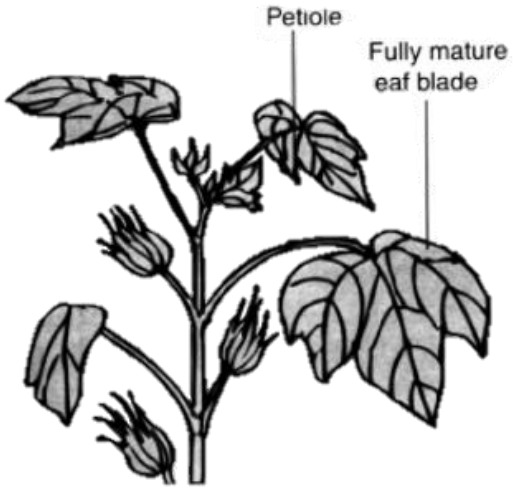
- LMRCS, Convent silt loam, **53 ppm K (Very Low)**
- SAREC, Captina silt loam, **114 ppm K (Medium)**
- RRS, Sharkey & Desha silt loams, **173 ppm K (Optimum)**
- 0, 40, 80, 120, 160, and 200 lb $K_2O$/ac
  (0, 37, 74, 112, 149, 186 kg K $ha^{-1}$), preplant incorporated, RBD with 4 reps
- DP2020B3XF, planted on May 8, 16 and 17
- Tissue-K concentration & seedcotton yield

# Fine-tuning Fertilizer-K Rate Recommendations

**Tissue sampling**

- 15 leaf & petioles/plot
  - 1st square
  - 1st flower
  - weakly sampling until boll fill
- Oven-dried, grind, acid-digest, & K concentration analysis

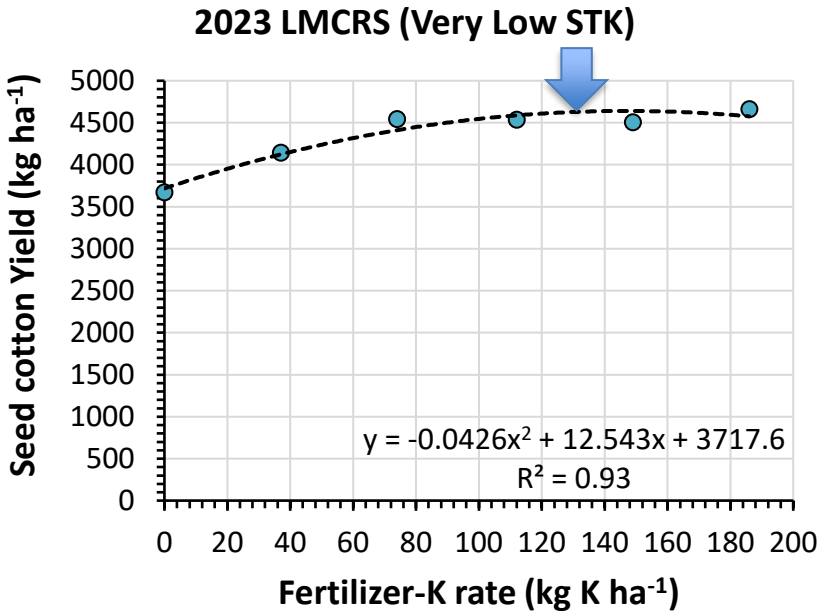


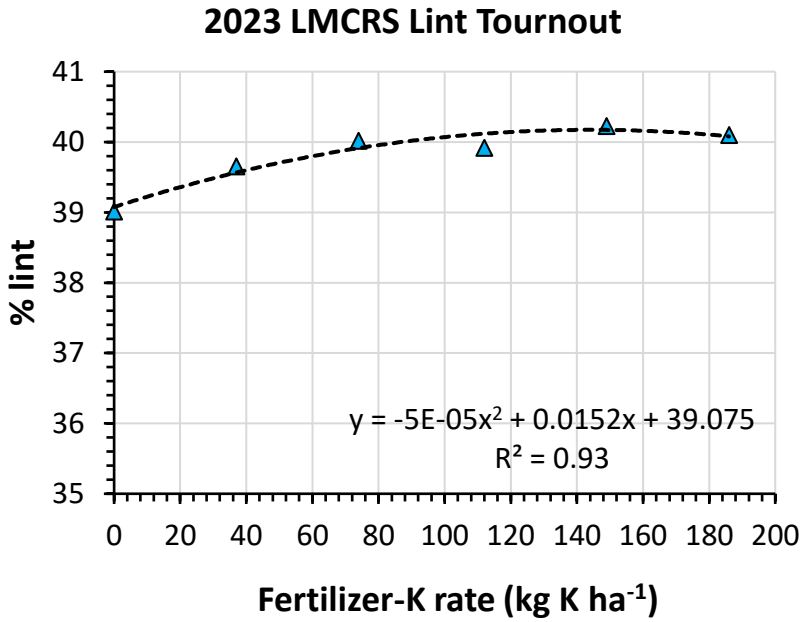

Abaye, A., 1996


**Petioles** **Leaves**

# Cotton Yield Response to Fertilizer-K Rate

## Seedcotton yield in response to fertilizer-K rate at Marianna (LMCRS), Fayetteville (SAREC), and Rohwer (RRS) locations in 2023




P < 0.0031
CV (%): 7.9

~20% yield increase with fertilization

No yield increase with rates above our current recommendations

# Cotton Yield Response to Fertilizer-K Rate

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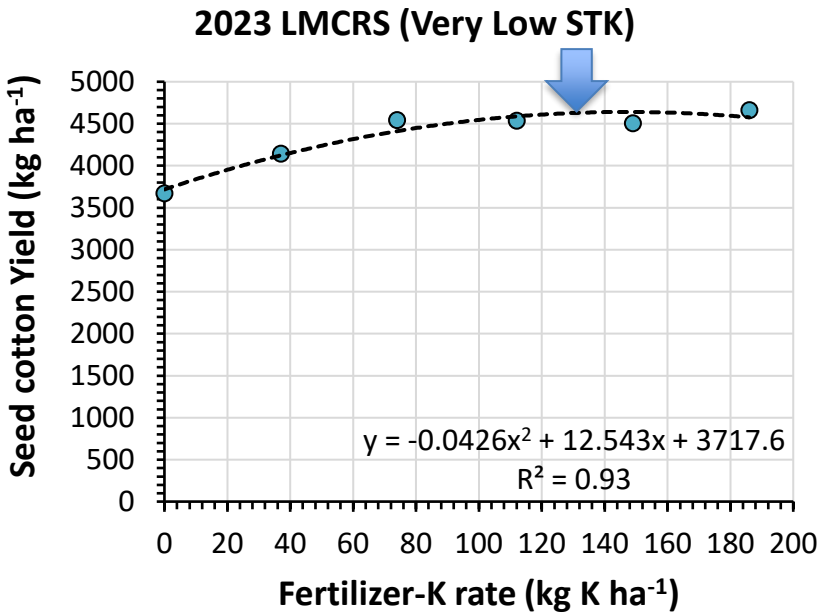


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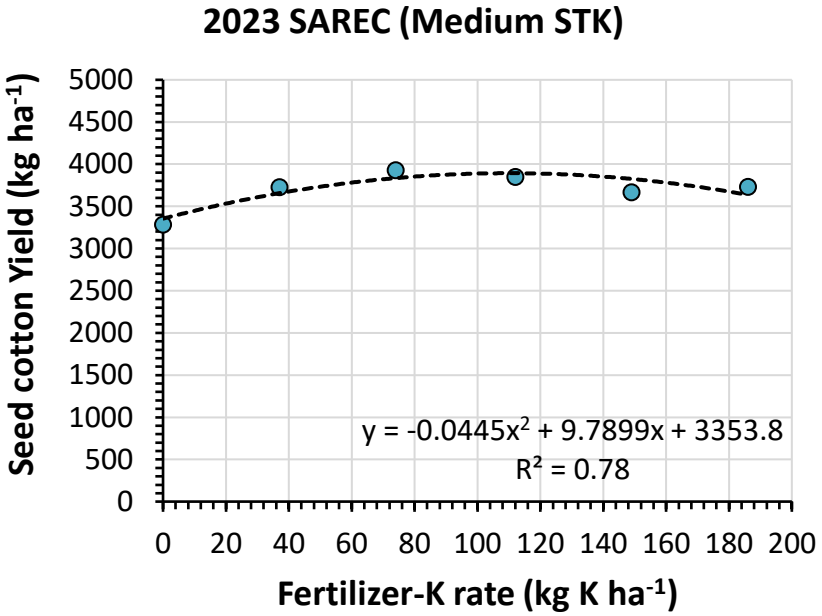
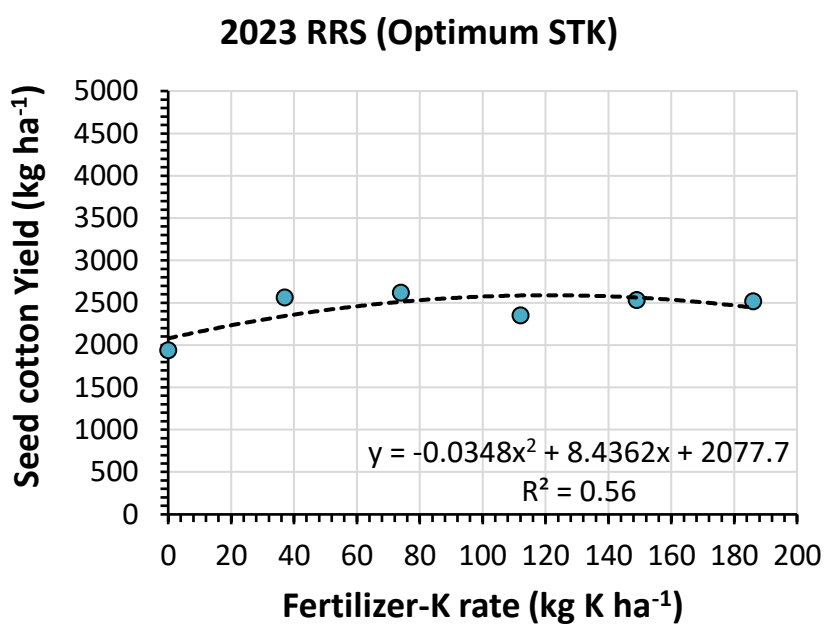



P < 0.7496
CV (%): 19.2




P < 0.2390
CV (%): 14.9

Soil Nutrient
K

Crop
Cotton

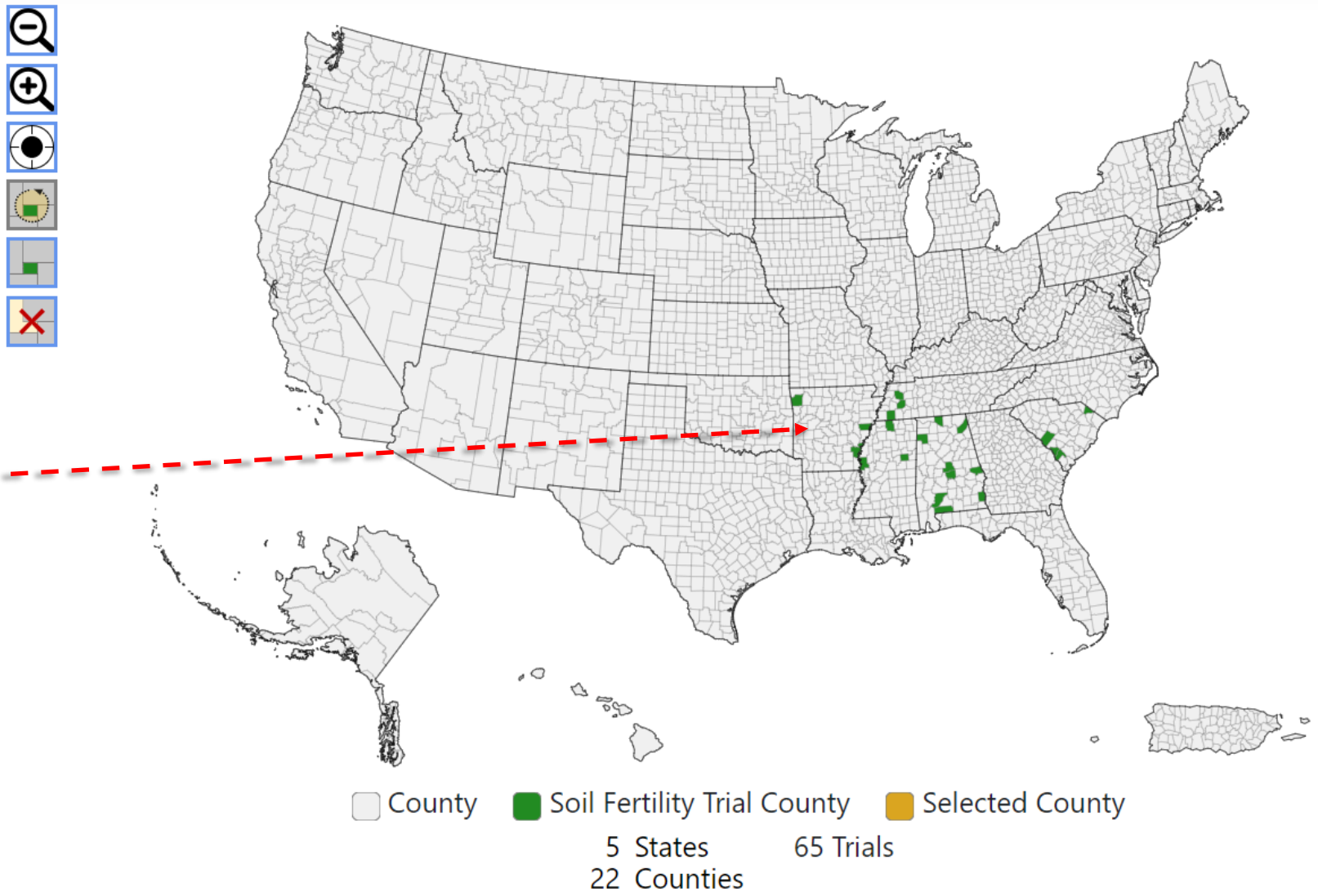
States/Territories

Mapped Soil Series

Years
From 1949 to 2023

Soil Sample Depths (in.)
- 0 to 2
- 0 to 4
- 0 to 6
- 0 to 12
- 2 to 6
- 4 to 12
- 6 to 12
- 12 to 24

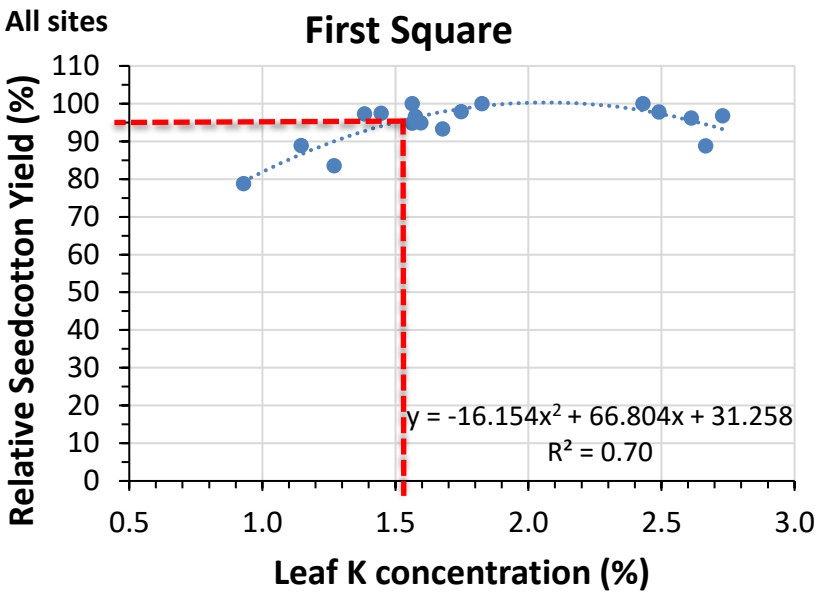
Soil Test Method

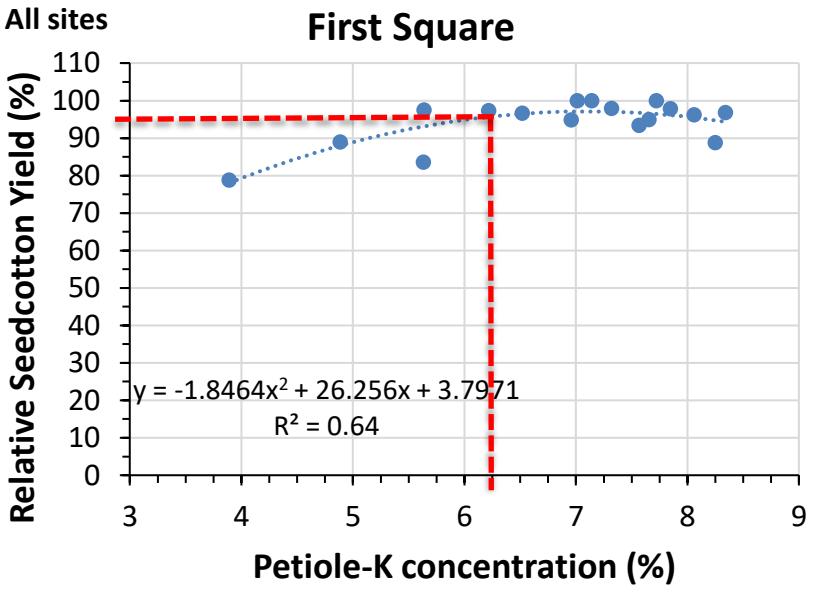


# Cotton Critical Leaf-K and Petiole-K concentrations

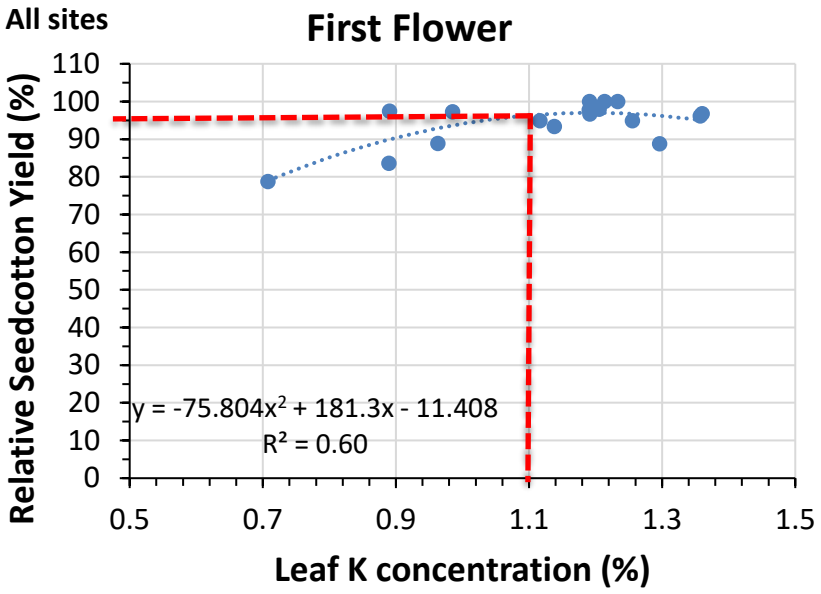

**Examples from the literature @ flowering:**

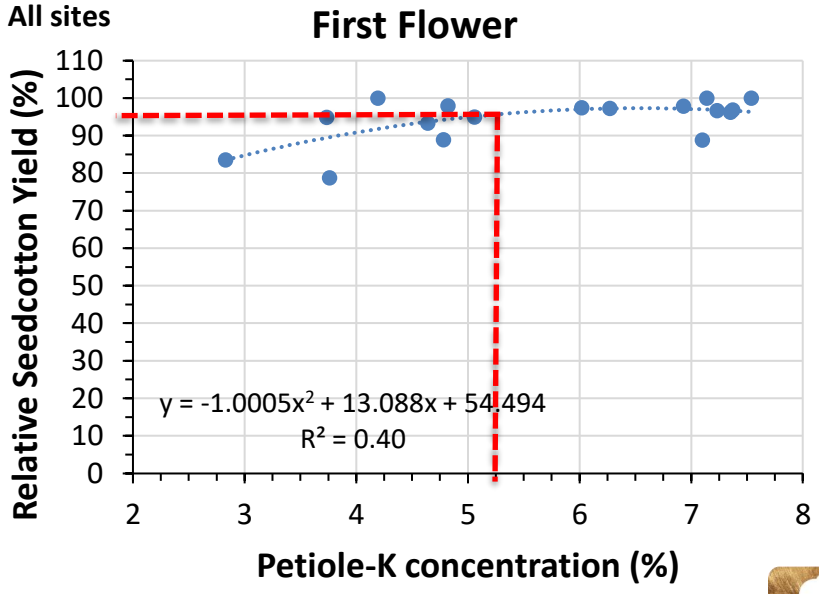
- 2.1% critical leaf-K conc.
- ~4% petiole-K conc. sufficiency



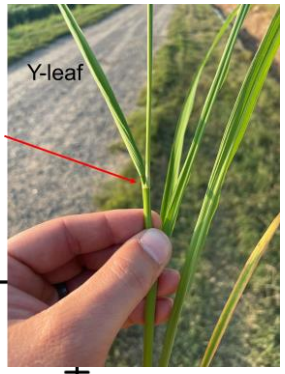


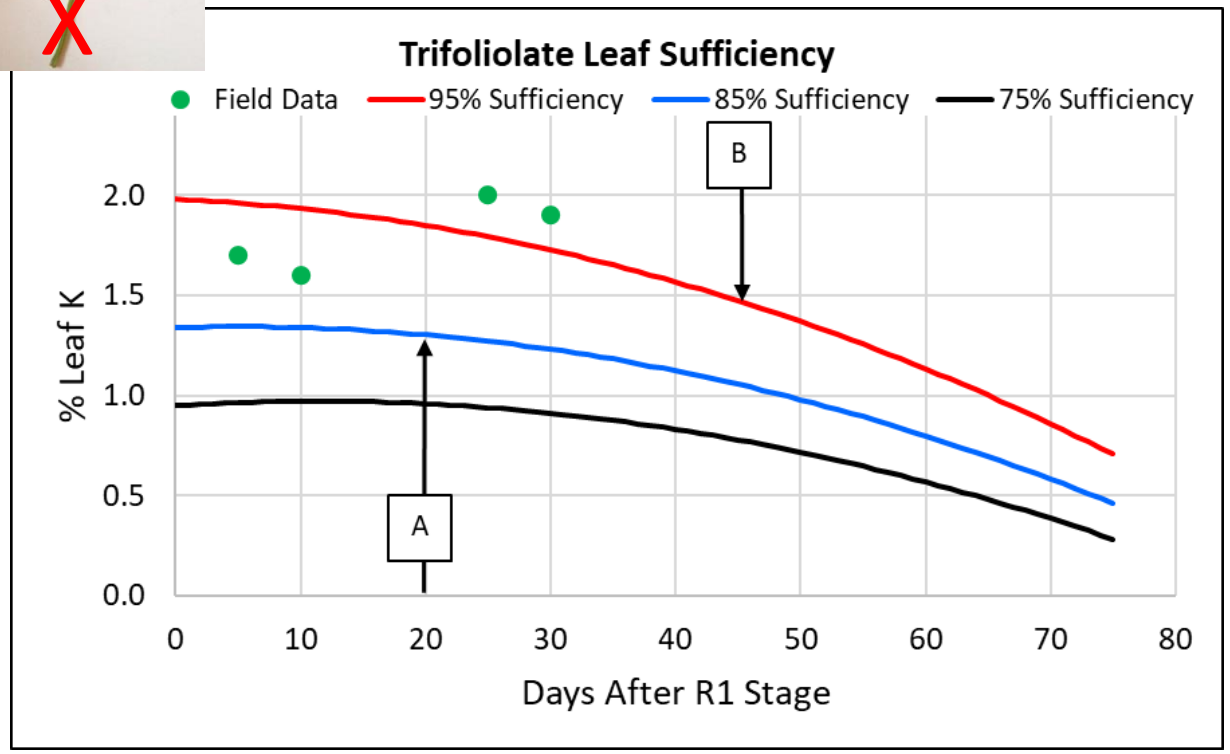


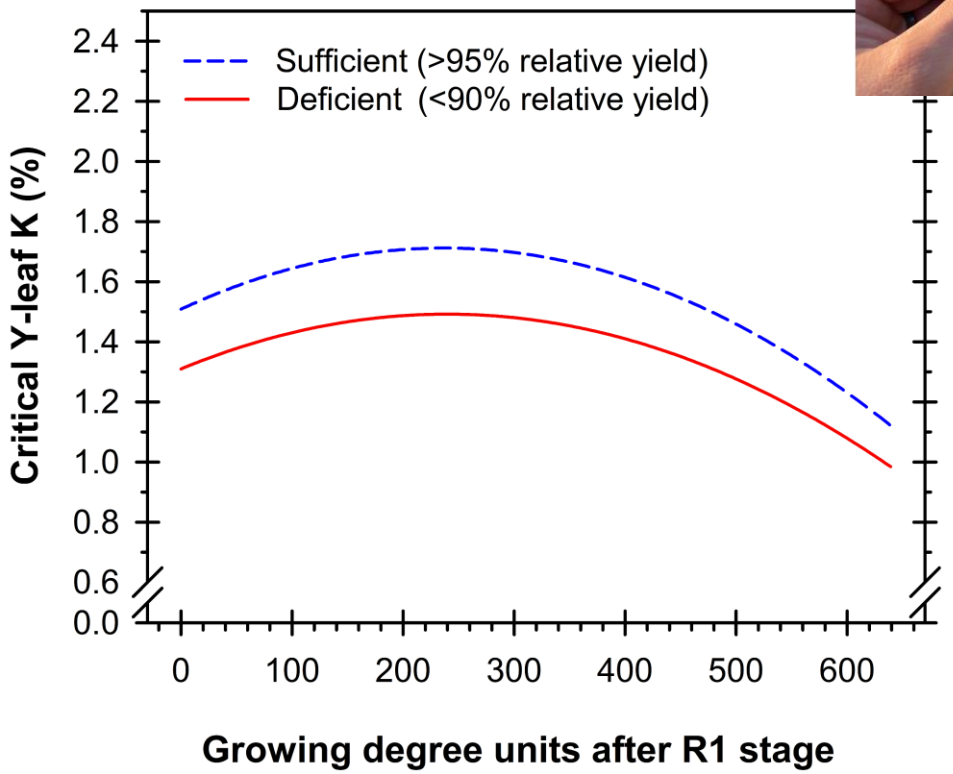



# Dynamic critical leaf-K concentration for rice & soybean

## Tissue testing is key for in-season nutrient management!





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ARKANSAS RICE CHECK-OFF

ARKANSAS SOYBEAN PROMOTION BOARD

*Agronomy Journal.* 2021;113:5472–5482.
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*Agrosyst Geosci Environ.* 2022;5:e20248.
https://doi.org/10.1002/agg2.20248

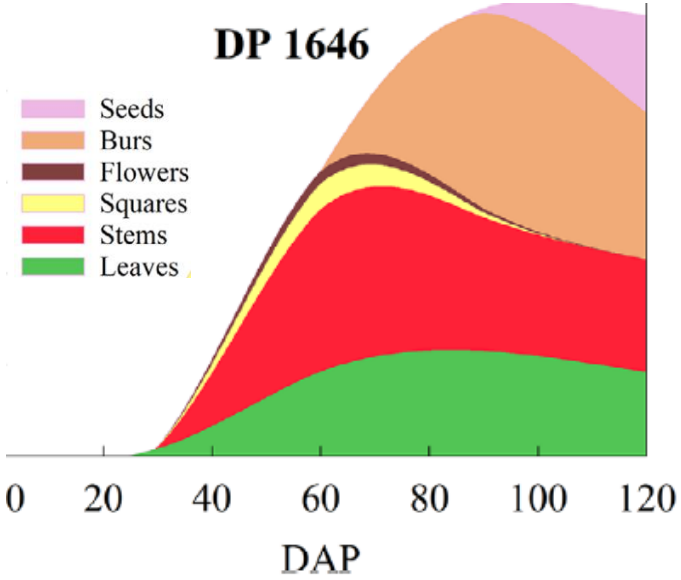
# Cotton Response to Fertilizer-K Rate and Timing

## I diagnosed a K deficiency, now what?

- How much will it impact cotton yield?
- Can I salvage yield potential with in-season fertilization?
- How much time do I have to apply a corrective K rate?
- What rate do I need to apply?

## Fine-tuning fertilizer-K recommendations (ongoing):

- Improving our fertilizer-K rate correlation and calibration database
- Establishing critical cotton leaf- and petiole-K concentrations
- Evaluating in-season fertilization to correct K deficiency and maintain yield potential




Partitioning of K by days after planting (DAP). Source: Pabuayon et al. (2020)

# *Thank you!*

# *Questions?*


## Gerson L. Drescher

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Cotton Incorporated

SOIL TESTING

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FERTILIZER RECOMMENDATION SUPPORT TOOL

SOIL FERTILITY