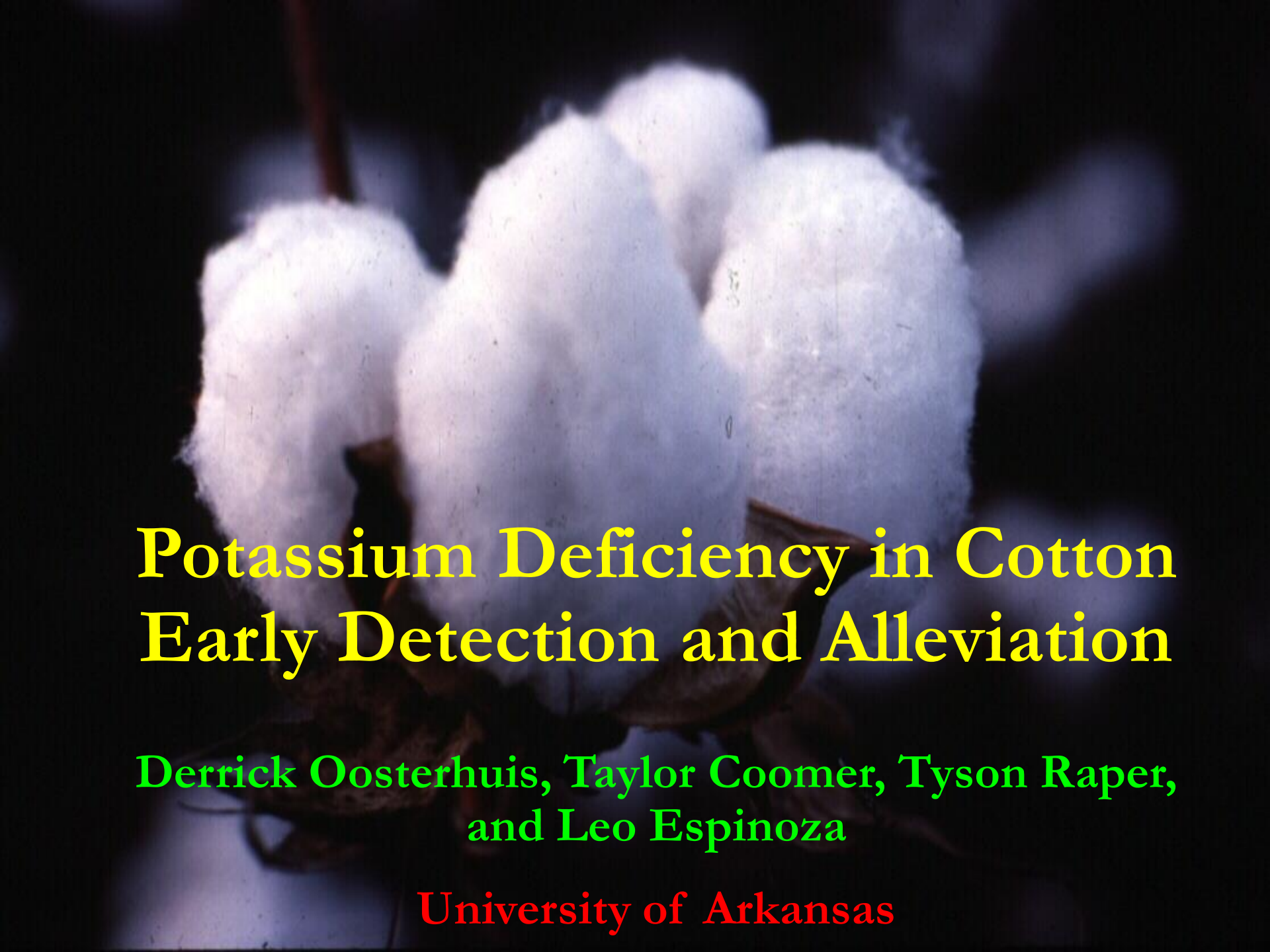


Potassium Deficiency in Cotton Early Detection and Alleviation

Derrick Oosterhuis, Taylor Coomer, Tyson Raper, and Leo Espinoza

University of Arkansas

Importance of Potassium

Potassium plays a major role in metabolism, growth, development, yield and quality.

Deficiencies of K result in problems in numerous physiological functions, resulting in poor growth, and reduced yield, and also decreased resistance to stress.

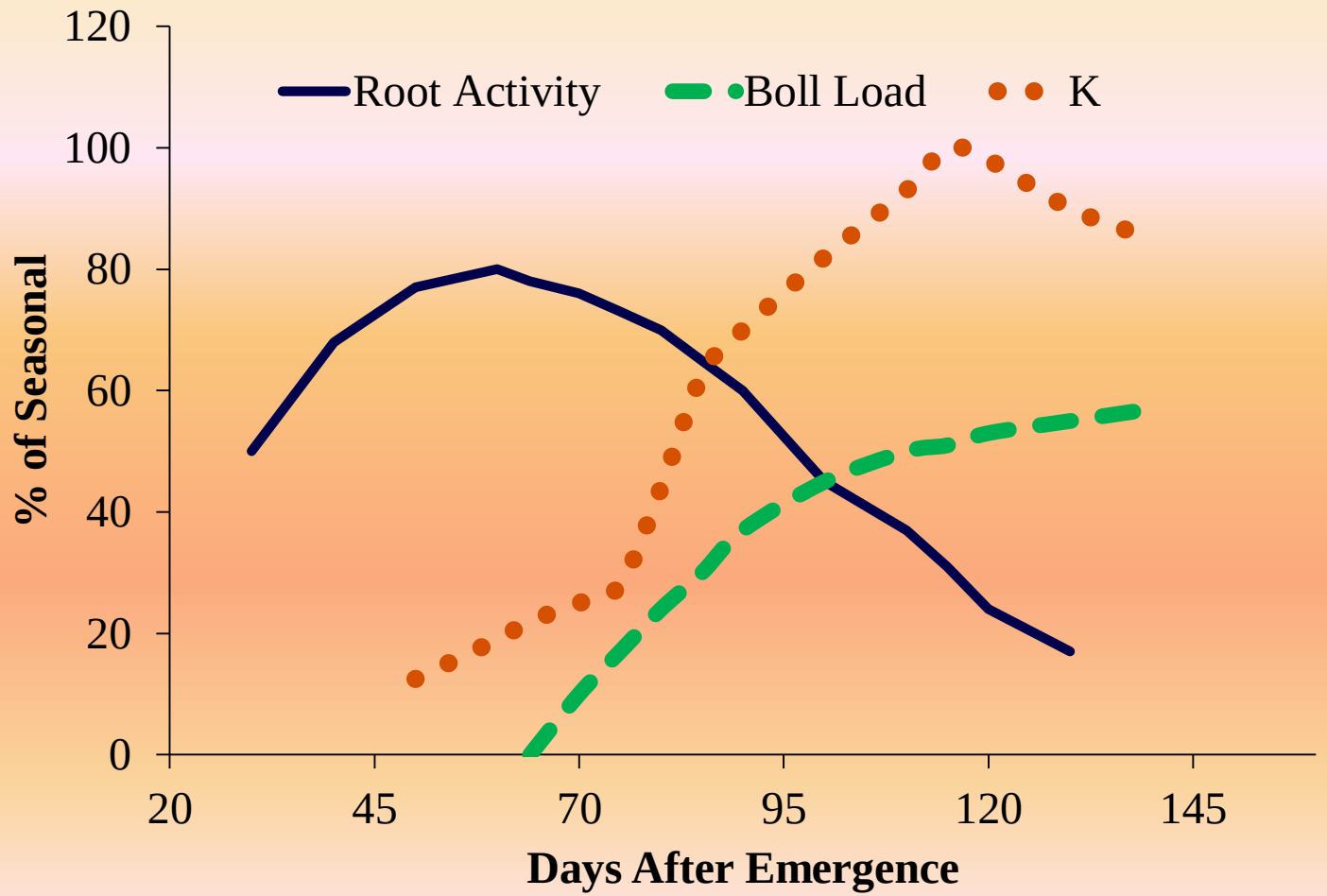
Introduction

- **An average cotton crop requires 105 kg K/ha, with a peak of 3-5 kg k/ha/day** *(Mullins and Burmester, 1990, Halevy, 1976)*

- **Natural fertility cannot maintain sufficient levels of K in intensive production agriculture**
  - Large quantities of K removed over short time
  - K losses to runoff, leaching to lower soil horizons


Widespread potassium deficiency has occurred across the US Cotton Belt
K deficiency first appears in the upper canopy as a subtle interveinal chlorosis and spreads around the leaf margins.

Reason for Widespread Potassium Deficiencies in the US Cotton Belt



Avoidance of Potassium Deficiency

For proper plant growth and optimum yields, nutrient deficiencies are to be avoided.

However, K deficiencies often occur for a variety of reasons, and when they do they can be corrected by soil applications and timely foliar applications.

This necessitates an understanding of plant K usage during the season, and the early detection of a pending deficiency.

Objectives

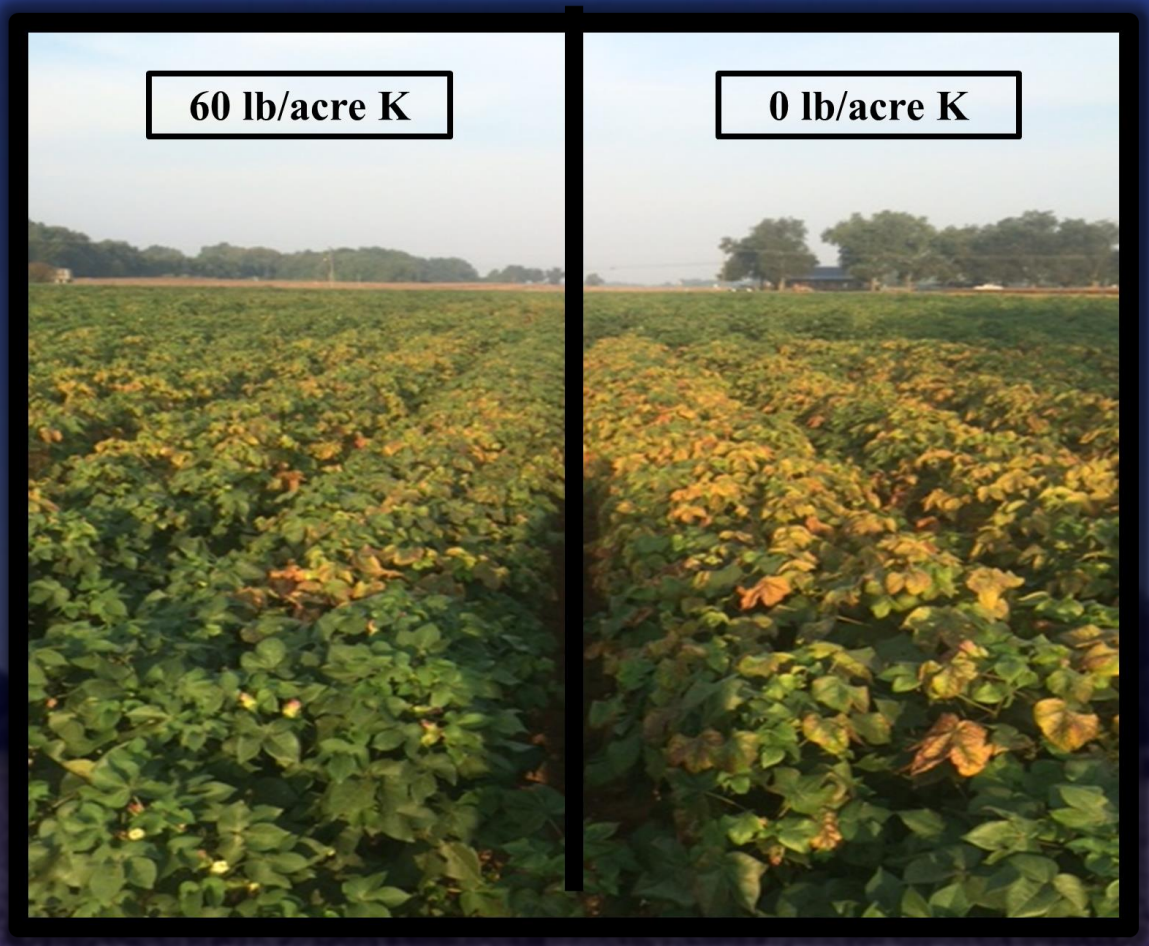
- **Examine partitioning of K in cotton plant components during the season, and effects of soil available K and new transgenic cultivars.**

- **Investigate remote sensing/spectral reflectance with varying levels of K fertility**

Materials and Methods

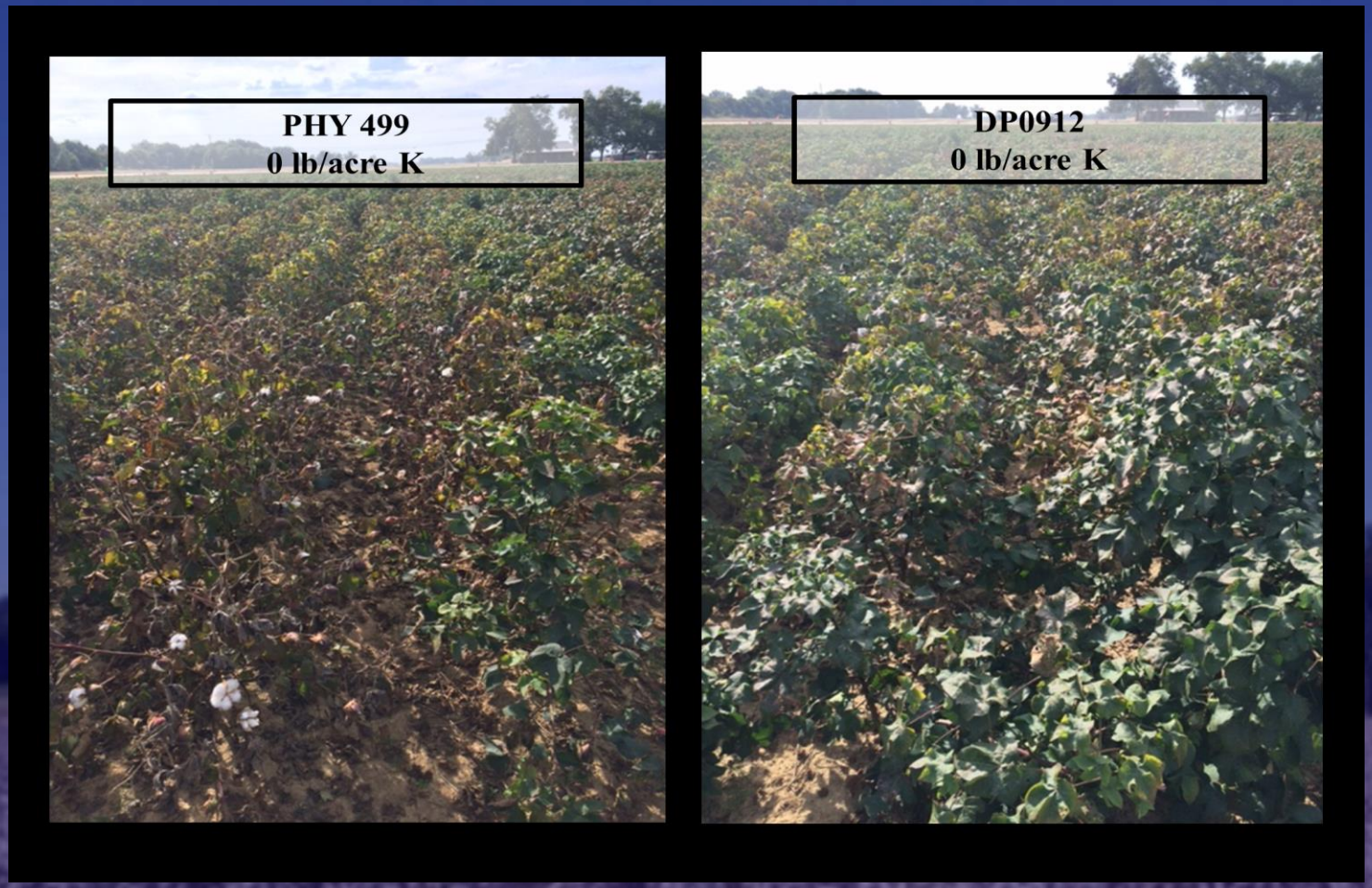
- Randomized strip complete block trial in 2014 in Marianna, AR
- Treatments consisted of 0, 30, 60, & 90 lb K_2O/acre applied to three cotton (*Gossypium hirsutum* L.) cultivars Phytogen 499 WRF, Stoneville 5458 B2RF, and DeltaPine 0912 B2RF.
- Whole plant samples taken at four stages: pinhead square, first flower, three weeks after first flower, and six weeks after first flower.
- Plants were divided into stems, leaves, petioles, and reproductive components.
- Plant parts were dried, ground, and analyzed for K concentration.

Visual K Deficiency with low K fertilization



K Deficiency symptoms in PHY499 three weeks after first flower

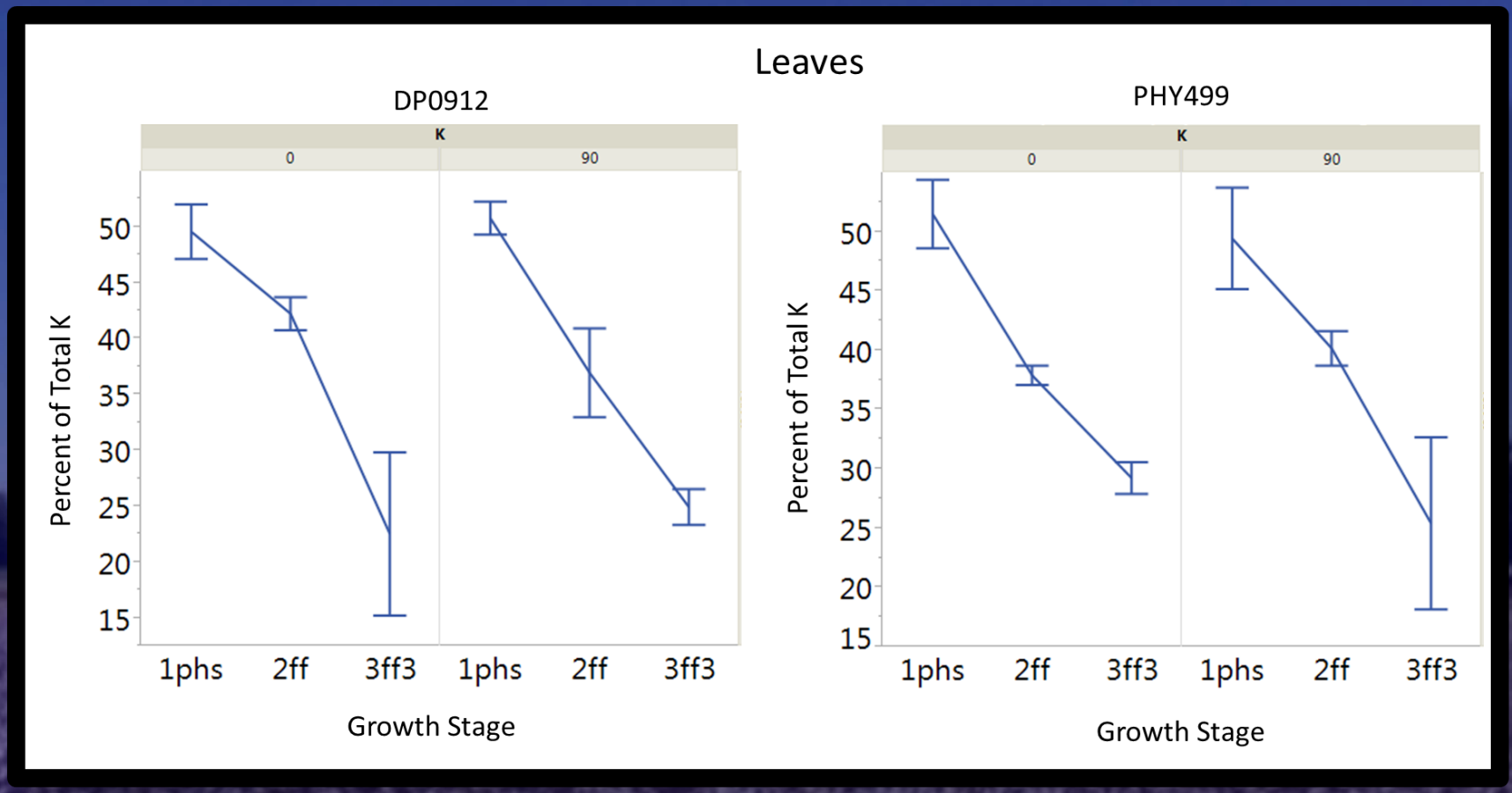
K Deficiency Response by Cultivar



PHY499 and DP0912 with 0 lb K2O/acre at six weeks after first flower

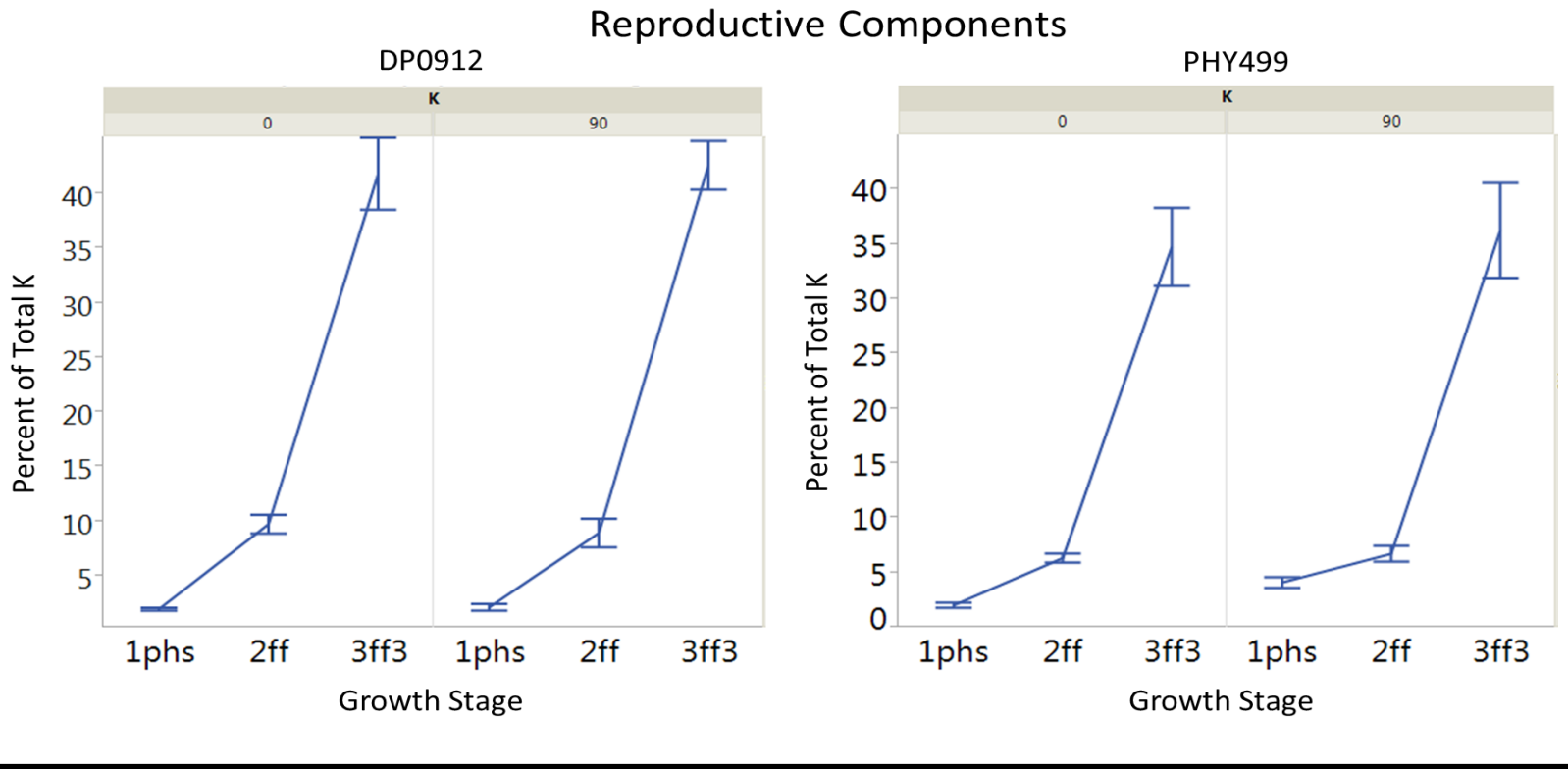
Leaf K During the Season

- Leaf K decreased significantly throughout the season ($p<0.05$).
- No significant difference between treatments at each growth stage ($p<0.05$)

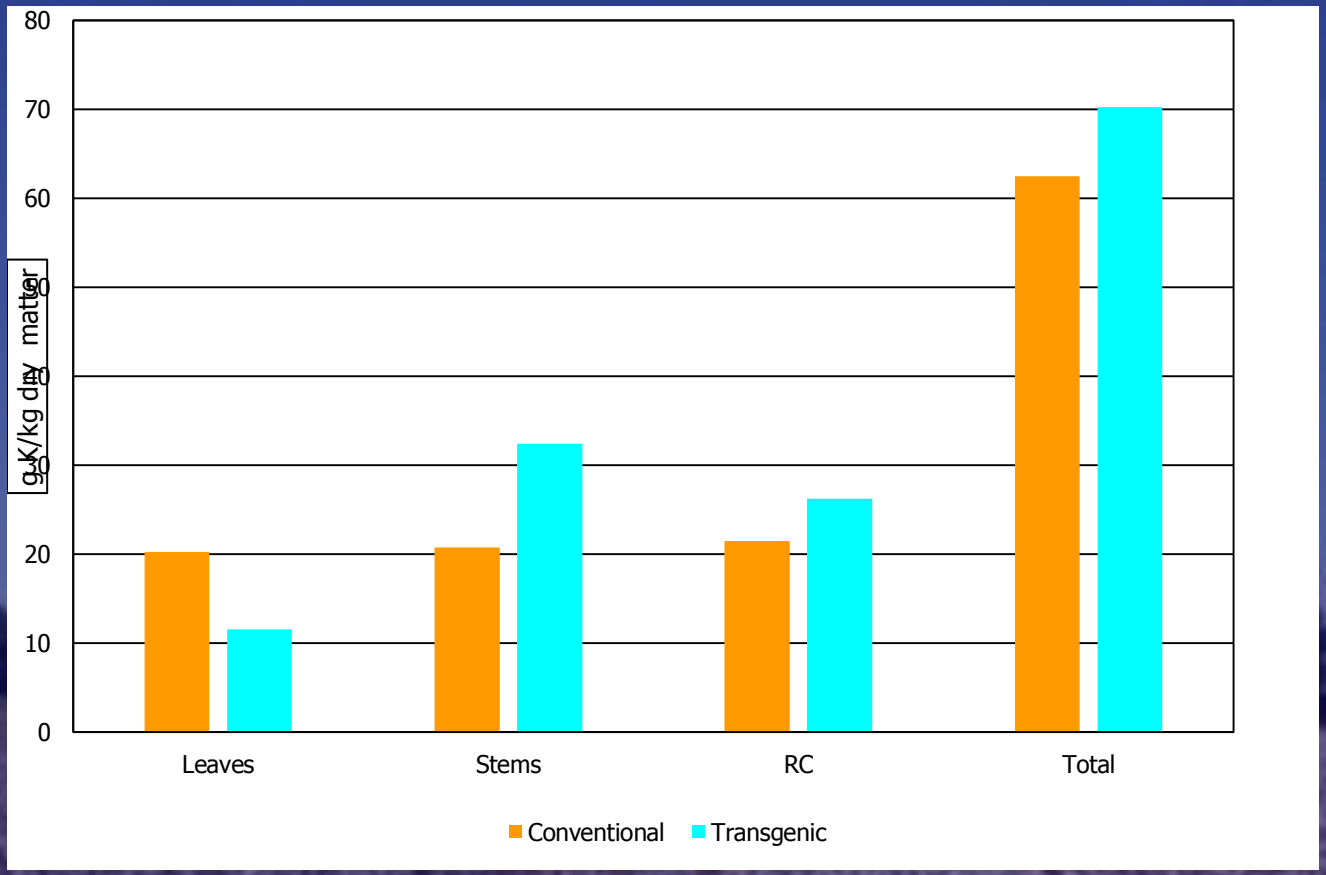


K in Reproductive Components

- Reproductive component K increased significantly over the growing season ($p<0.05$) across all treatments
- DP0912 had significantly higher K than did PHY499 in reproductive components within K levels ($p<0.05$)



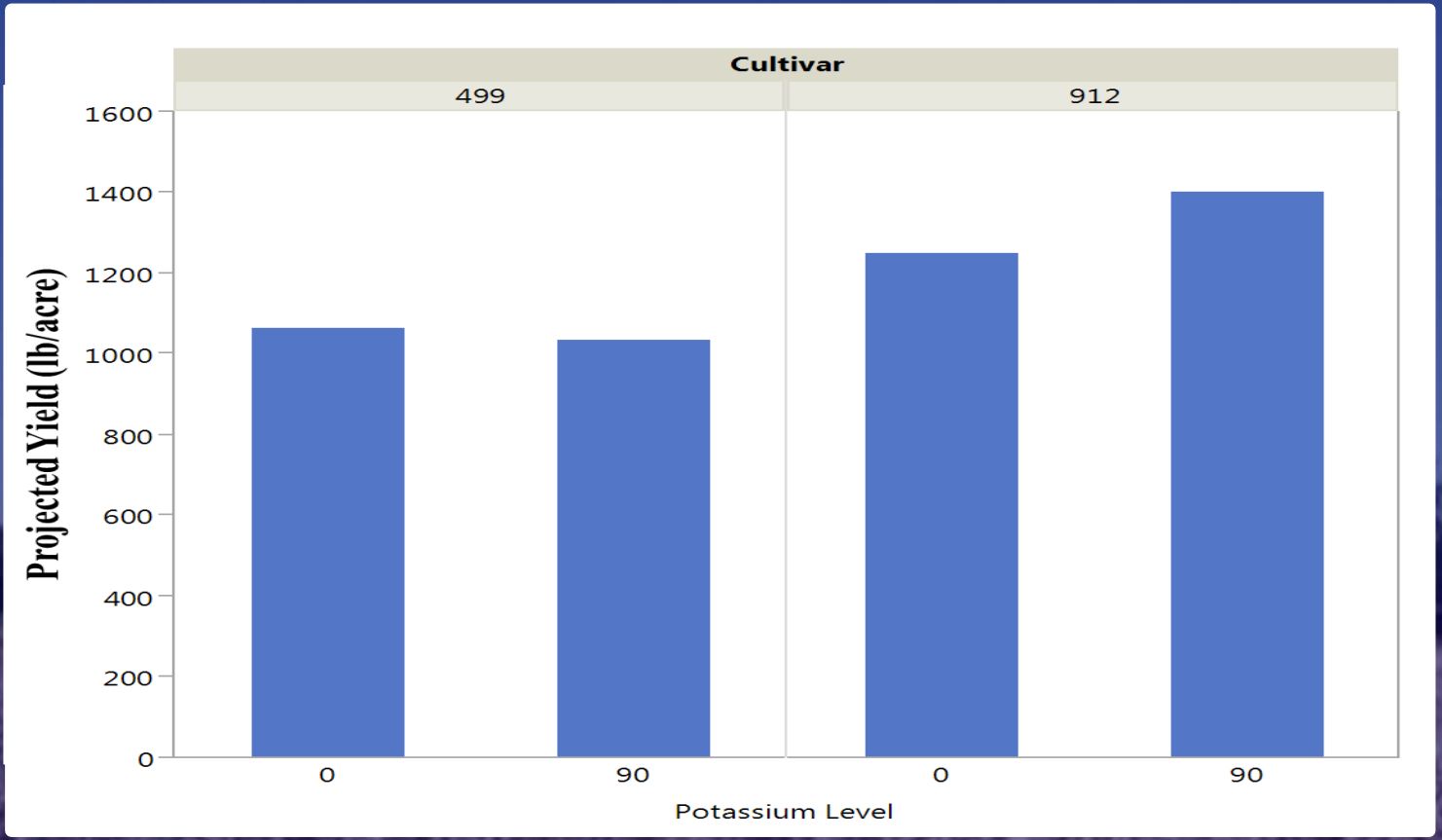
Comparison of K Partitioning in Conventional and Transgenic Cotton measured at early flowering



Yield Results

Significant cultivar differences in yield response to K were recorded.

e.g. DP0912 had a significant response, whereas PHY499 did not.



Conclusions

- There were yield difference in cultivars in response to K, but limited responses in partitioning of K in the plant.
  In low K situations, DP0912 yielded higher and partitioned more K into reproductive components than did PHY499.

- There were no differences in leaf K partitioning in low or high K environments.

- Over the growing season, K in reproductive components increased as leaf K decreased.

Spectral Reflectance and Potassium Deficiency

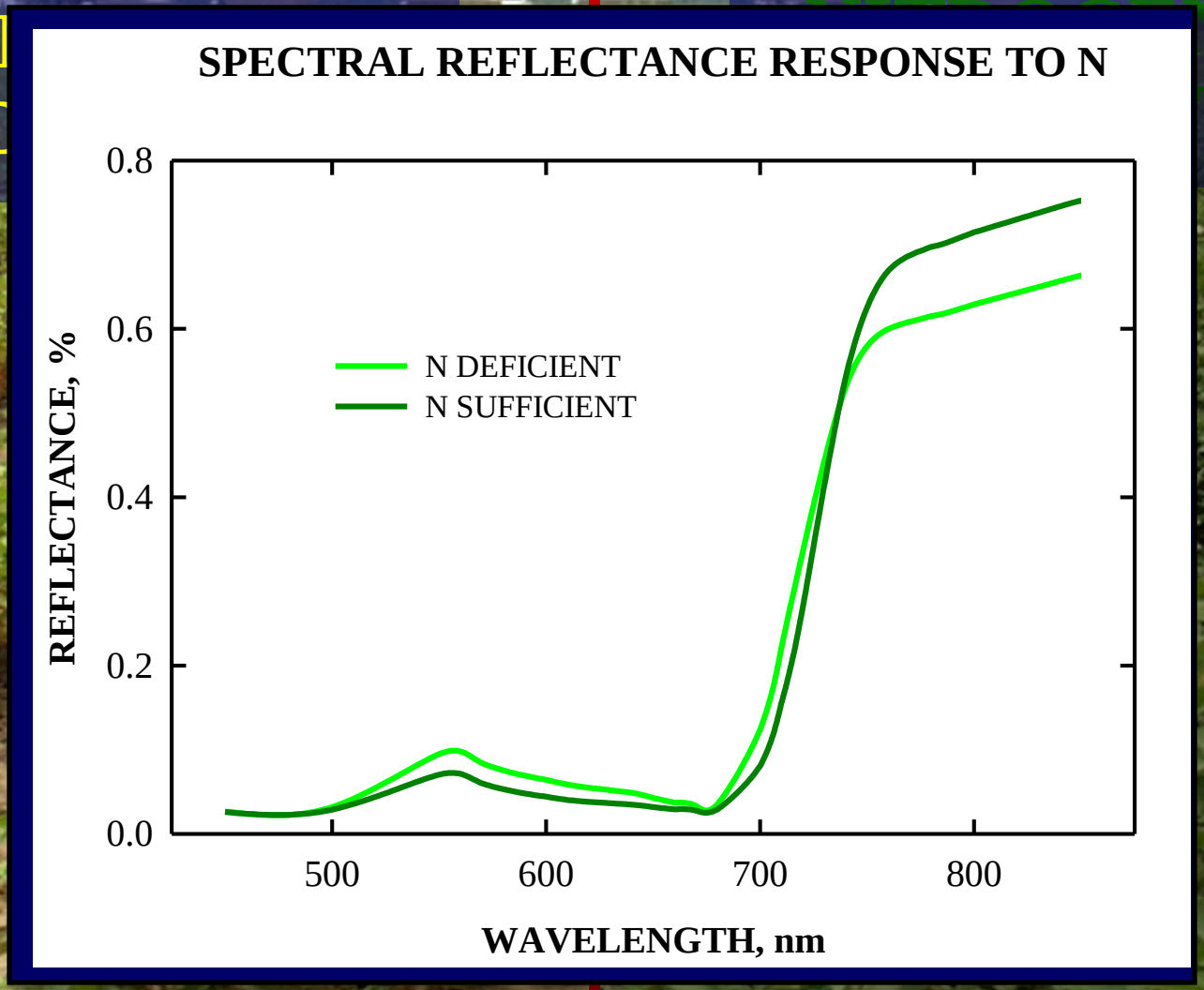
The objective was to see if we could use remote sensing to accurately predict the onset of potassium deficiency.

Relate spectral reflectance to changes in K partitioning from leaves to reproductive components, under conditions of decreasing soil available K.

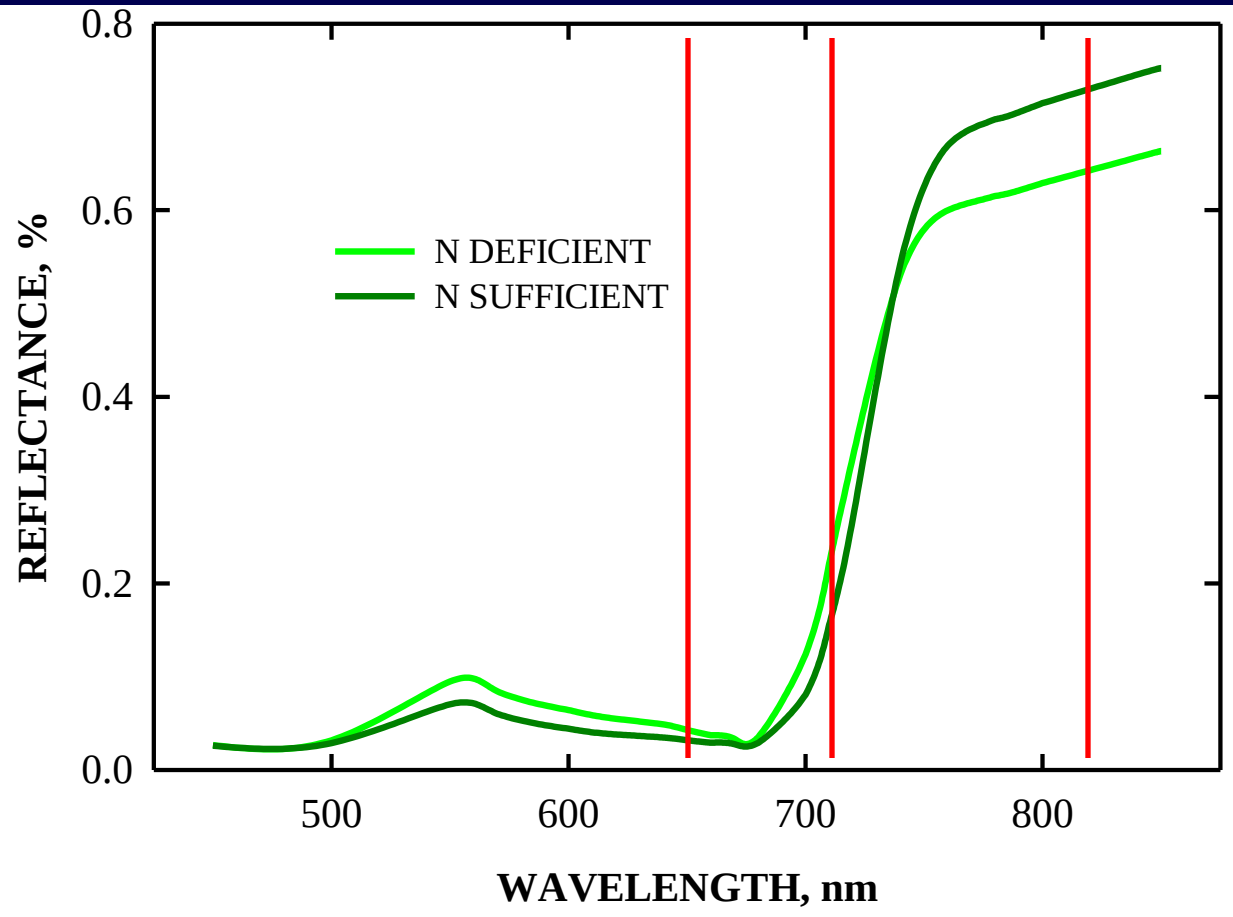
Determine if currently available, N-sensitive indices calculated from active sensors are sensitive to:

- K deficiencies
- Differences in popular cotton cultivars

BACKGROUND


SPECTRAL REFLECTANCE RESPONSE TO N
REFLECTANCE, %
0.0
0.2
0.4
0.6
0.8
500
600
700
800
WAVELENGTH, nm
N DEFICIENT
N SUFFICIENT

BACKGROUND



$$NDVI = \frac{R_{NIR} - R_{RED}}{R_{NIR} + R_{RED}}$$

$$NDRE = \frac{R_{NIR} - R_{EDGE}}{R_{NIR} + R_{EDGE}}$$

$$CCCI = \frac{\text{NDRE}}{\text{NDVI}}$$

METHODS

- Location
  - Lon Mann Cotton Research Station, Marianna, AR

METHODS

- Location
  - Long-term cotton fertility trail, maintained by Dr. Leo Espinoza

METHODS

- **Cultural**
  - Strip trial
  - 4 row plots, 50’ length
  - Planted @ 3.5 plants/ft, 38” beds
  - Furrow irrigated, as needed (generally on a weekly basis)
  - Fertilizer N applied uniformly. Split, 60/40 @ emergence/first square
- **Treatments**
  - K_2O rate
    - 0, 30, 60, 90 lb K_2O/acre
  - Cultivar
    - Phytogen 499 WRF
    - Stoneville 5458 B2RF
    - DeltaPine 0912 B2RF

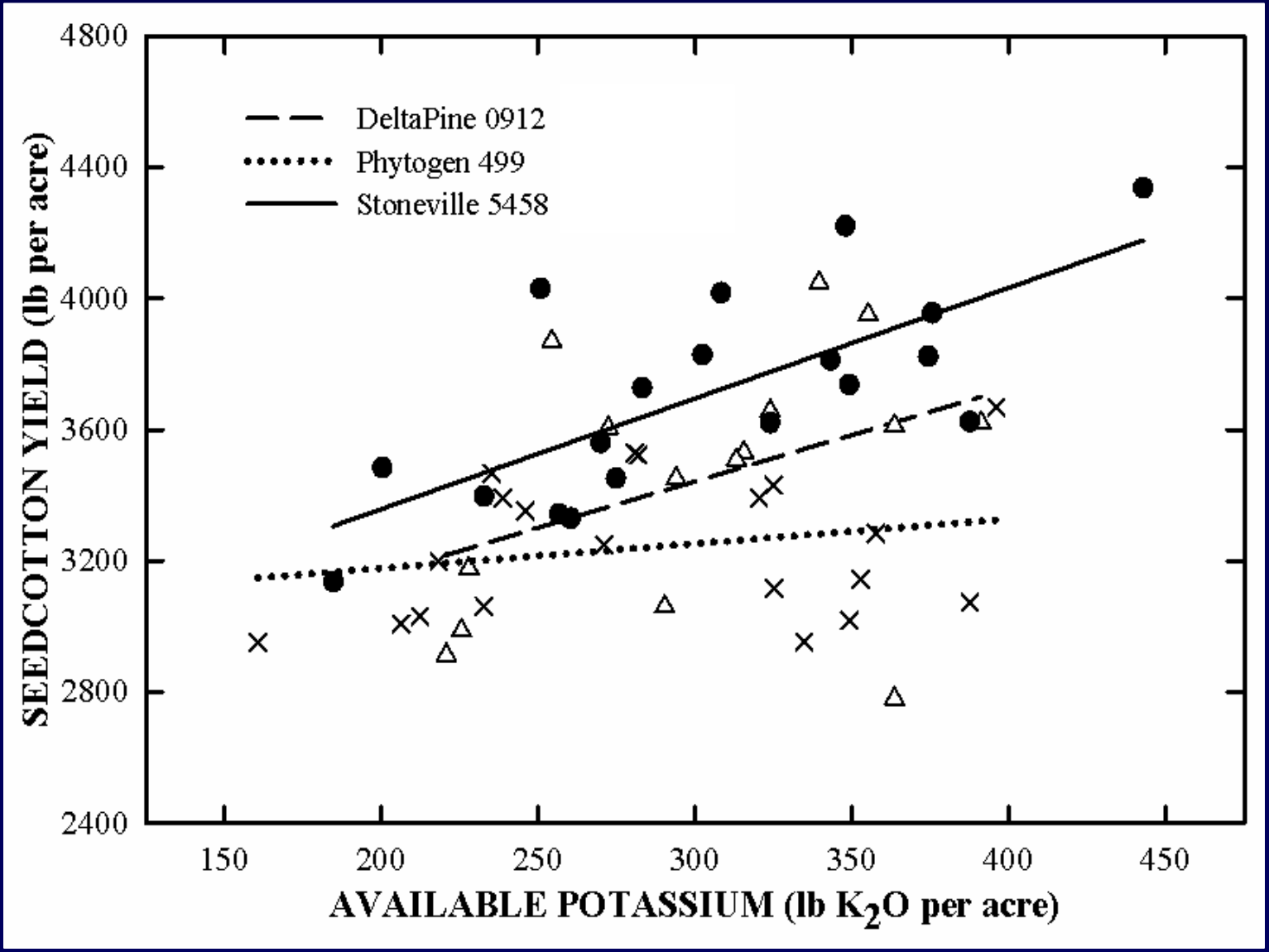
METHODS

- **Measurements**
  - Soil samples
    - Bed shoulder at 6” depth. Mehlich 3 extraction. Processed and analyzed by the University of Arkansas Soil Testing Laboratory
  - **Tissue**
    - Leaf N, K
    - Petiole N, K
    - Flower N,K
  - **Reflectance**
    - Crop Circle ACS-470
      - Single unit
      - Height of 36”
      - Measured 1 weeks before, at first flower and at peak flower

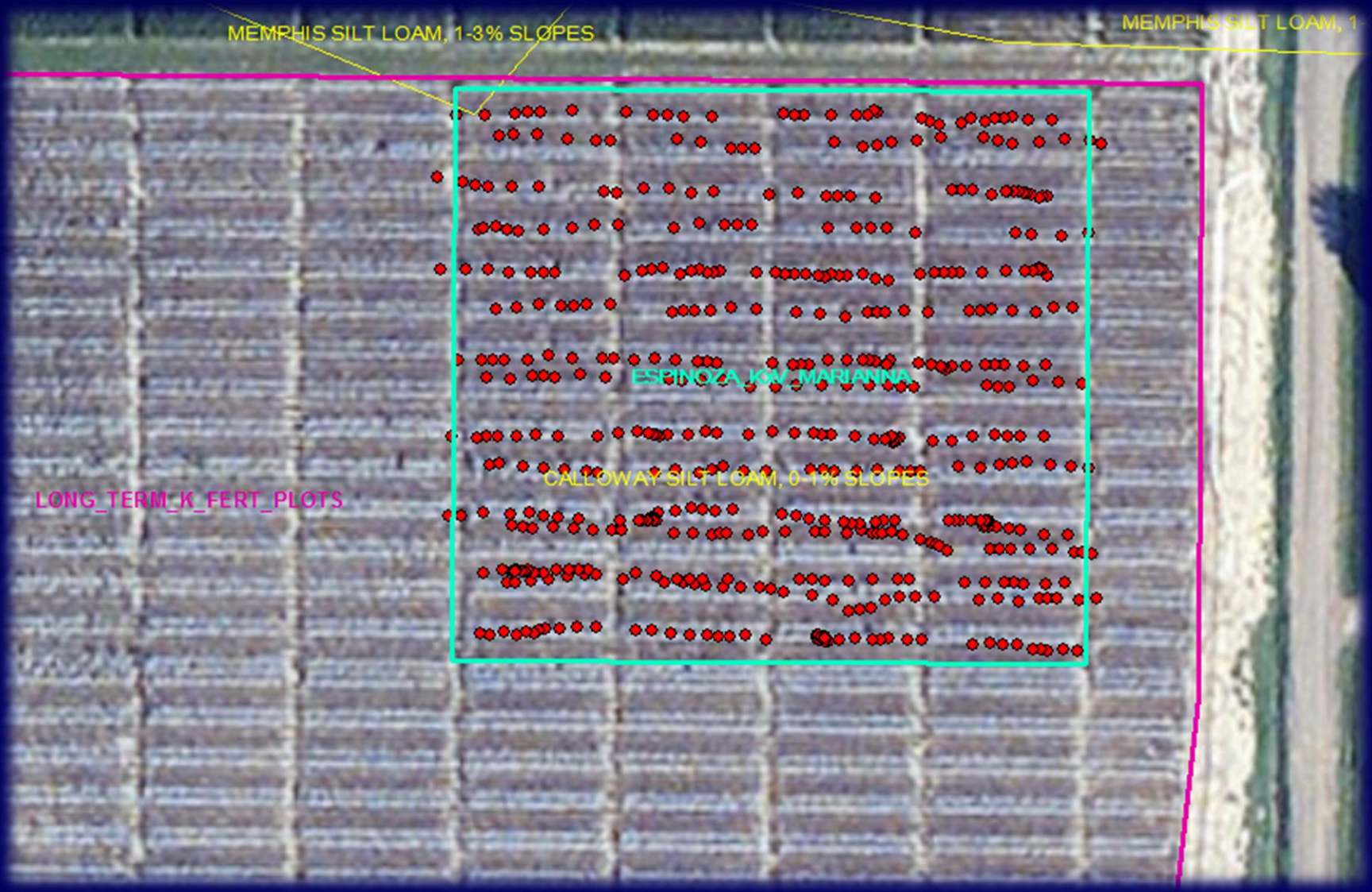
RESULTS

• Phytogen 499 WRF • Stoneville 5458 B2RF • DeltaPine 0912 B2RF

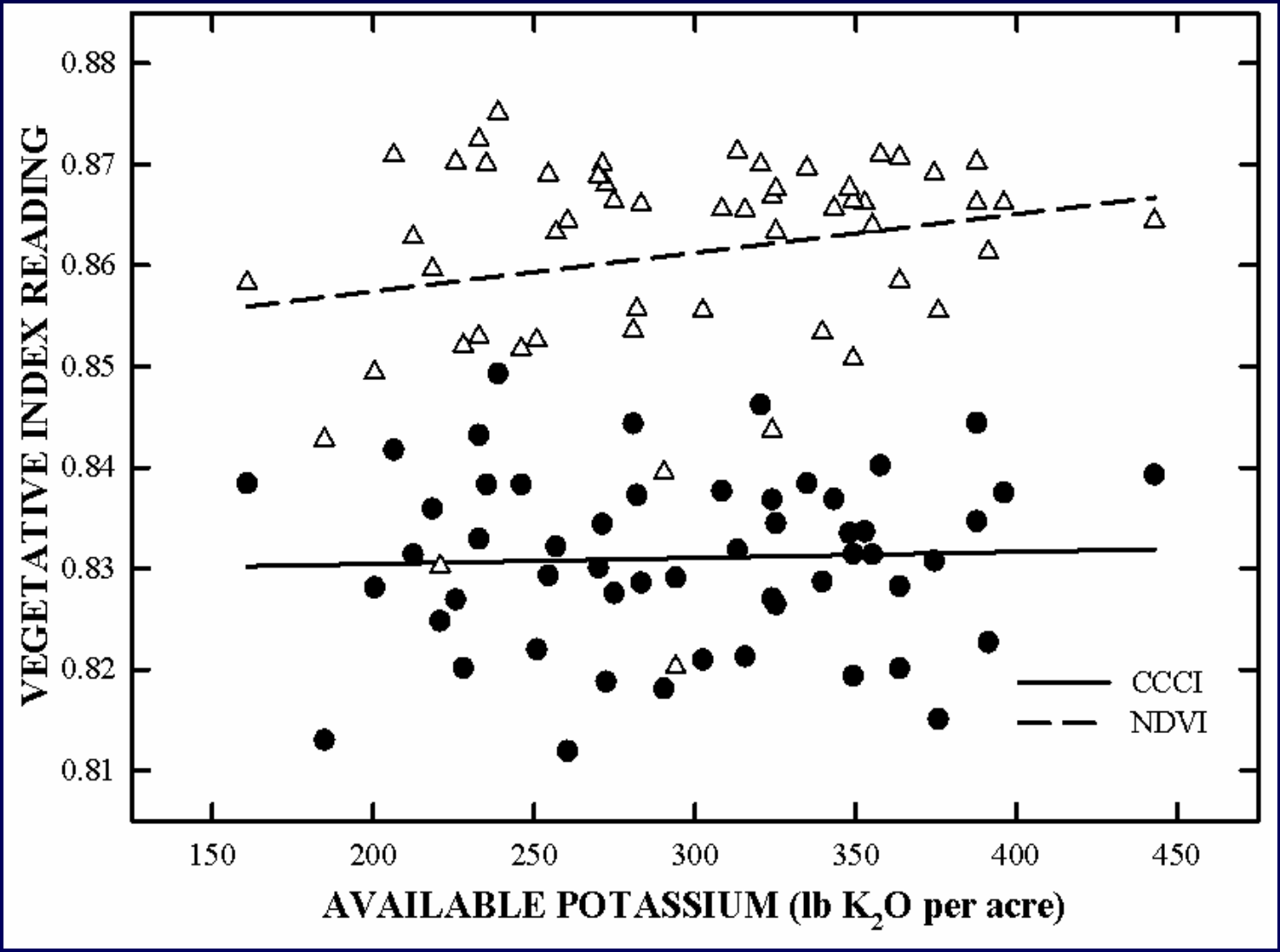
RESULTS


DeltaPine 0912
Phytogen 499
Stoneville 5458
SEEDCOTTON YIELD (lb per acre)
4800
4400
4000
3600
3200
2800
2400
150
200
250
300
350
400
450
AVAILABLE POTASSIUM (lb K_2O per acre)

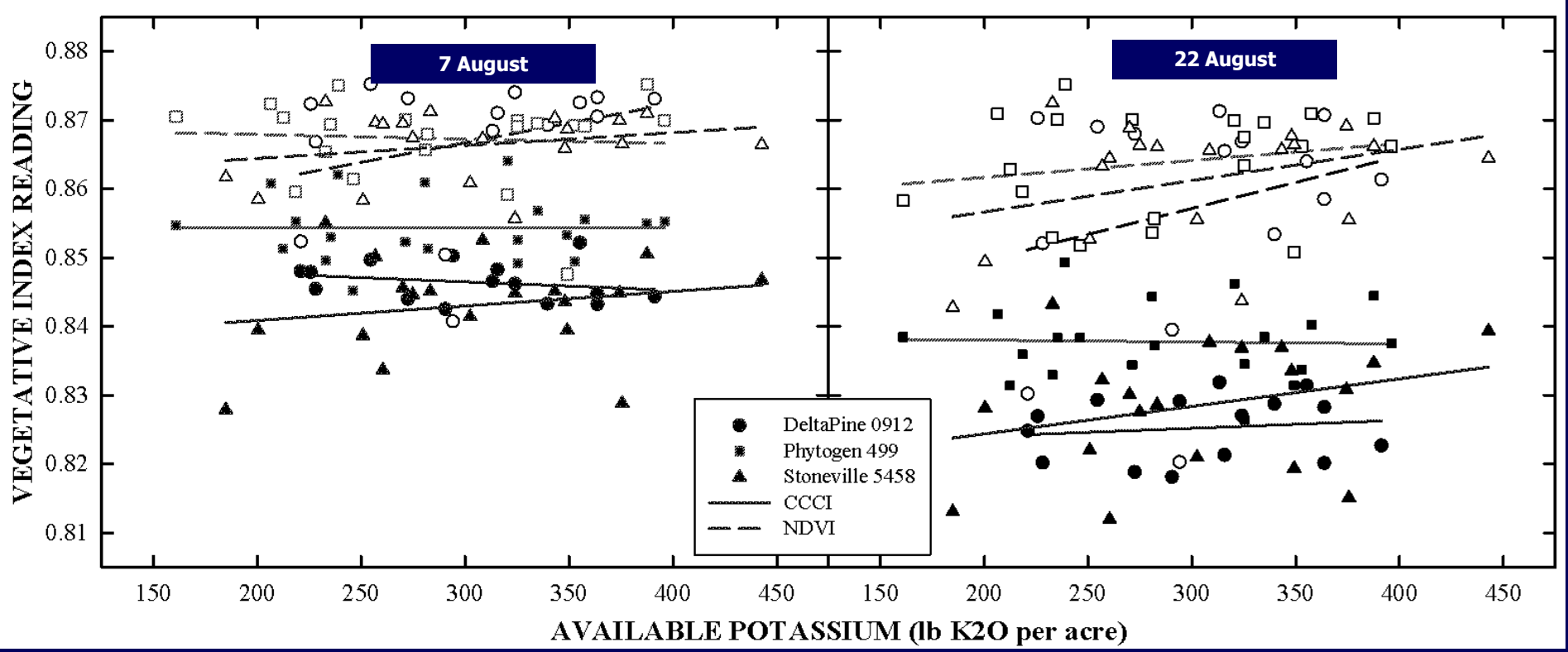
RESULTS


MEMPHIS SILT LOAM, 1-3% SLOPES
MEMPHIS SILT LOAM, 1
ESPINOZA_KW_MARIANNA
CALLOWAY SILT LOAM, 0-1% SLOPES
LONG_TERM_K_FERT_PLOTS

RESULTS


VEGETATIVE INDEX READING
0.88
0.87
0.86
0.85
0.84
0.83
0.82
0.81
150
200
250
300
350
400
450
AVAILABLE POTASSIUM (lb K_2O per acre)
CCCI
NDVI

RESULTS


7 August
22 August
VEGETATIVE INDEX READING
0.88
0.87
0.86
0.85
0.84
0.83
0.82
0.81
150
200
250
300
350
400
450
AVAILABLE POTASSIUM (lb K2O per acre)
DeltaPine 0912
Phytogen 499
Stoneville 5458
CCCI
NDVI

CONCLUSIONS

- **K and Reflectance**
  - Decrease in NDVI with K deficiency
  - Limited response of CCCI with K deficiency
- **Cultivar and Reflectance**
  - PHY499 had higher NDVI, CCCI values
  - ST5458 and DP0912 very similar
- **CCCI**
  - Significant response to cultivar

OVERALL SUMMARY

Partitioning of Potassium:

- K partitioning in the plant changed with the progression of the season.
- Small change in partitioning of K with decreasing available soil K.
- **Over the growing season, K in reproductive components increased as leaf K decreased.**
- Modern transgenic cultivars partition more to reproductive components.

Spectral Reflectance:

- Significant increases of NDVI as available K increases suggests that NDVI based algorithms have the potential to recommend increased fertilizer N when K deficiencies exist.
- CCCI showed limited response with K deficiency, but response to cultivar.
- Significant responses of both NDVI and CCI to changes in variety suggest some correctional factor must be developed before on-the-go sensors utilizing these indices can be accurately used. In contrast CCCI does not appear to be susceptible to such errors.


Thank you for
your attention