Project Title: **Impact of Soil Applied Potassium on Cotton Yield, Quality, and Plant Growth across the Cotton Belt**

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Date: 1/23/2016

IMPACT OF SOIL APPLIED POTASSIUM ON COTTON YIELD ACROSS THE COTTONBELT

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Introduction

The frequency and severity of potassium (K) deficiency symptoms in cotton have increased in some soils in the U.S. Cotton Belt over the past decade or so. Insufficient levels plant available K in these regions are likely decreasing yields and fiber quality and leading to decrease profits for cotton producers. Deficiency symptoms may be observed beginning at first flower but increase in severity as the boll load and boll fill period progress (Reddy et al., 2000). Potassium plays a major role in several critical process, including photosynthesis, activation of protein enzymes, increases disease and drought resistance, and positively affects cotton fiber yield and quality. Previous research has shown 44 lb/acre/bale K will be removed annually from lint and seed harvest (Oosterhuis, 2001). Increased yield potential in new varieties and better insect management have pushed cotton yields to 3-4 bales and can exceed 5 bales on irrigated land. These high yields put a substantial demand on the roots' ability to uptake sufficient K and other nutrients to meet the physiological demand of the plant, seed, and lint. As K demand continues to increase, deep profile soil samples indicate a reduced level of plant available K in some production areas. According to the Nutrient Use Geographic Information System (NuGIS) webpage, K_2O balance is negative (-11 to -50lbs/a) for the majority of the cotton production regions (IPNI, 2012).

It is well documented that cotton is more sensitive to low K availability than most other major field crops, and often shows symptoms of K deficiency on soils not considered deficient (Cassman et al, 1989). Hence cotton may be the first crop to reach the tipping point for low K levels and may serve as a "miner's canary" for K deficiencies to come in other row crops.

Objectives

The first objective is to quantify the K+ soil levels, surface and with depth, from several major cotton production regions in the Cotton Belt experiencing K deficiencies. The second objective is to evaluate the impact of application methods and rates of K+ on cotton yield, quality, and return on investment. Based on these finding, soil K recommendations will be re-evaluated and modified as appropriate to optimize yields.

Materials and Methods

The 2015 trials were initiated at 12 locations across the CottonBelt, including Virginia, North Carolina, South Carolina, Alabama, Mississippi, Louisiana, Tennessee, Arkansas (2), Oklahoma, Texas (3) and Arizona. Soil samples were collected to a total depth of 24 inches from these locations and were analyzed at depth increments (0-6, 6-12, 12-24) by the Texas A&M Soil Testing Laboratory. Soil samples were collected from 4-6 weeks prior to planting the trial. The soil analysis results from a Melich III extraction method are presented in Figure 1. Potassium treatments, injected and broadcast incorporated, were applied 2-4 weeks prior to planting cotton. See Table 1 for treatments. The granular treatments were broadcast and incorporated to an approximate depth of 2 inches with tillage. The liquid potassium fertilizer was injected approximately 6 inches deep and 4 inches to the side of the row.

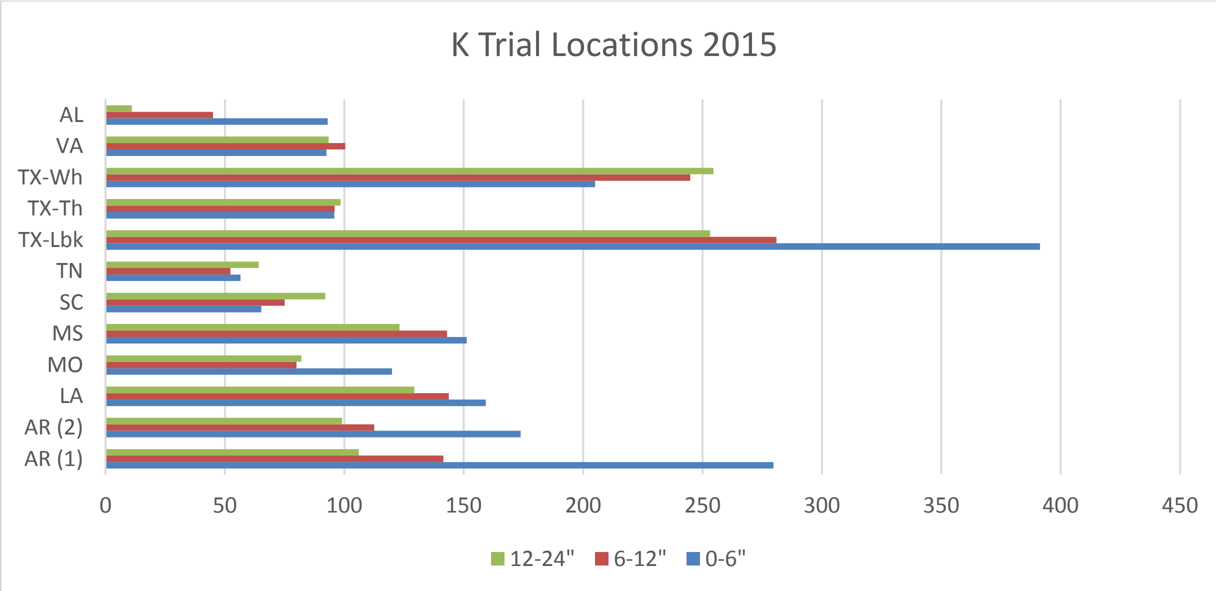

Figure 1. Soil test potassium levels for various soil depths for the cotton trial locations.

Table 1. Potassium application method and rates for 2015 trials.

Application method	**Rate (lb K_2O/A)**
Broadcast	0, 40, 80, 120, and 160
Deep banded	0, 40, 80, 120, and 160

Nitrogen, phosphorous, and other nutrients were applied at the recommended rate to obtain the maximum yield potential for each location. The cotton variety used across all locations was DeltaPine 1321B2RF. The plots were arranged in a Randomized Complete Block Design with four replications. Plot dimensions varied by location but were generally 4 rows wide and 40+ feet in length. In-season plant measurements included stand counts, plant height, total nodes, and leaf samples collected at 4 weeks after first flower. Leaf samples were sent to the Texas A&M Soil, Plant, and Water testing lab for K mineral analysis. After harvest the cotton was ginned and fiber samples sent to Cotton Inc. for HVI analysis. These data were analyzed in SAS using Fisher's LSD means separation formula.

Results and Discussion

Soil test indicate a range of K levels across the CottonBelt, with the lowest levels occurring in Virginia, South Carolina, Alabama Tennessee, and Williamson TX locations (Figure 1). At these locations, K levels were below quite deficient in K at each soil depth based on the Melich III extraction method. The Delta locations, except Tennessee, were near the current threshold of 125 ppm and no K would have been recommended at these sites for two bale yield potential. The Southwestern sites, Lubbock TX, Arizona, and Wharton TX all had high soil test levels. Across most locations, the soil K levels decrease with depth and indicate some level of K stratification and K mining with depth (Figure 1).

The plant growth measurements, leaf tissue K concentrations, and fiber quality data were collected for each location. However, the data has not been compiled thus far. For the presentation of yields, the locations are grouped by region, Eastern, Delta, and Southwestern. At the Eastern locations, yields ranged from 800 to 1400 lb/a for the three locations at the 0 lb K/a treatments (Figure 2). There was not significant (P=0.05) yield response for any of the locations to K rate or application method in 2015, despite all sites being below the current soil K threshold level. Only a numerical increase in lint yields at Alabama for the injected application method was observed. In the Delta region, locations with a good range of yield potential were identified with yields as high as 2300 lb/a in lint yield (Figure 3). However, despite the high yielding locations and soil K test levels being near soil test threshold levels, no significant increase in lint yield was obtained. The Tennessee location was a sandier soil location with low soil K levels, and at this location a numerical increase in yield was observed from both application methods. In the Southwestern locations, a significant yield response was observed at the Thrall, TX location, despite very low yields (Figure 4). At the Lubbock location with over 350 ppm K, a significant yield response was observed from the two highest K application rates for the injected application method. The Wharton, TX location and Arizona locations were both non-responsive locations, but soil K levels were well above the current soil K threshold level of 125 ppm.

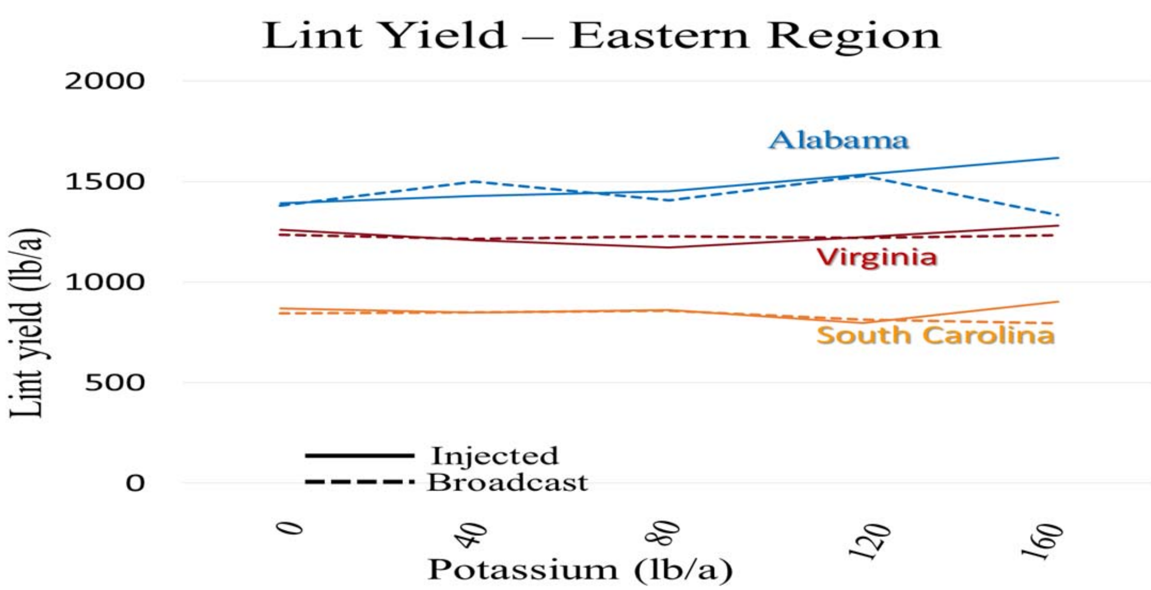

Figure 2. Cotton lint yield response to potassium rate and application method in the Eastern locations (Virginia, South Carolina, and Alabama) in 2015.

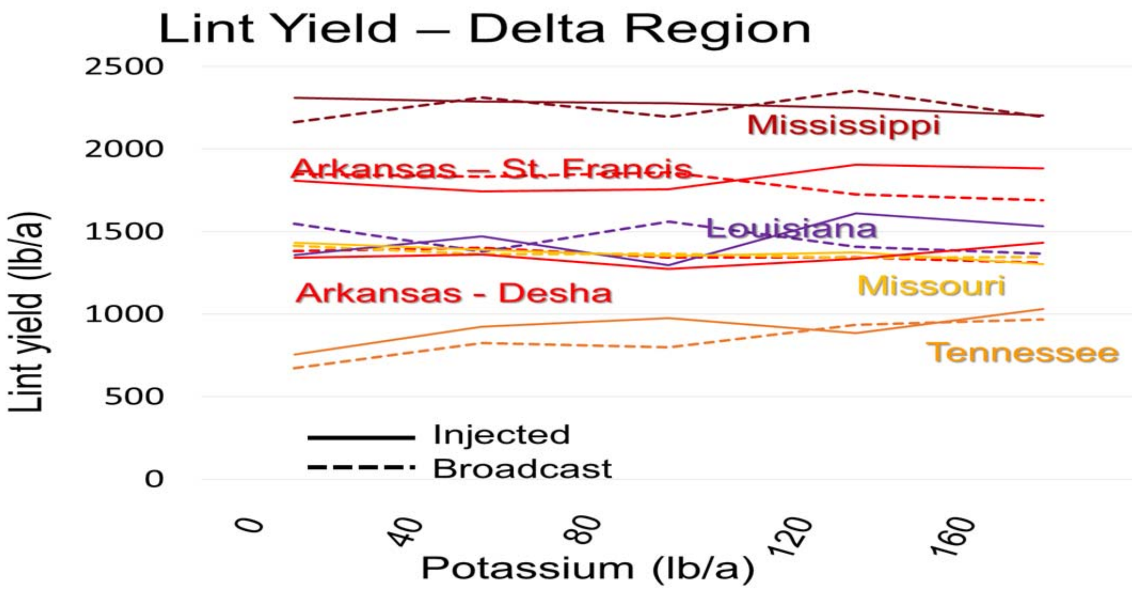

Figure 3. Cotton lint yield response to potassium rate and application method in the Delta region locations (Mississippi, Louisiana, Arkansas – St Francis, Arkansas – Desha, Missouri, and Tennessee) in 2015.

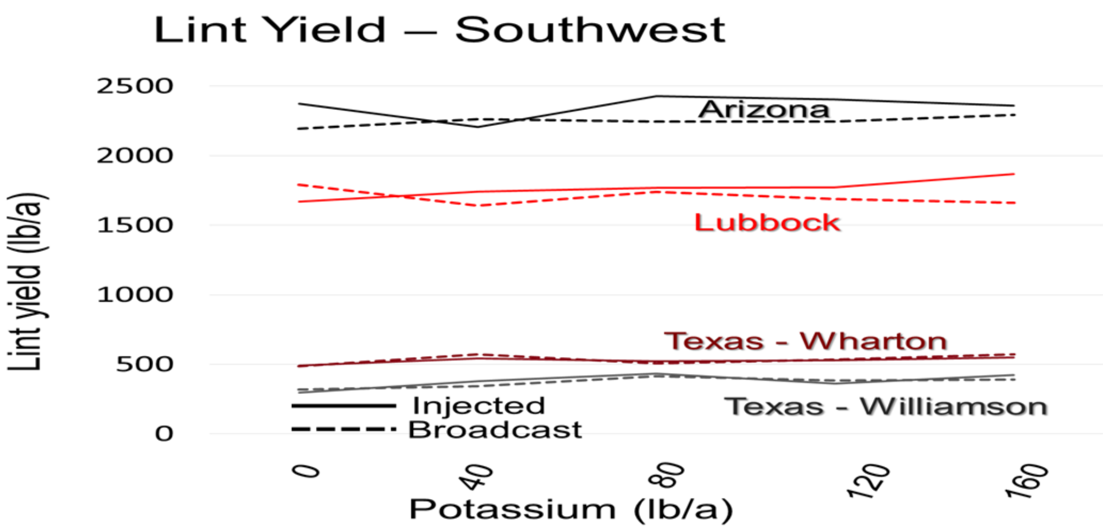

Figure 4. Cotton lint yield response to potassium rate and application method in the Southwestern locations (Texas-Thrall, Texas-Wharton, Texas-Lubbock, and Arizona) in 2015.

Acknowledgements

The authors would like to extend their appreciation to Cotton Incorporated, Fluid Fertilizer Foundation, and International Plant Nutrition Institute for providing financial support for this Cotton Specialist Working Group project.