Potassium Fertilization for Southern Cotton: New Genotypes, New Questions.

Lead Institution: Auburn University
Agronomy & Soils
Auburn University, AL 36849

Elizabeth Guertal,
Professor
Soil Fertility
Auburn University
Auburn, AL
guertea@auburn.edu
334-844-3999

Justification:

The study of potassium (K) fertilization of cotton has a long history (Oosterhuis, 2002), traceable to the first reports of the importance of K for prevention of 'rust' of cotton (Atkinson, 1891). Southern cotton fields have a long history of productivity; with cotton long the top agricultural commodity crop in the southern cotton belt. In 2013, the National Cotton Council's 30th Annual Early Season Planting Intentions Survey indicates that growers intended to plant 9.01 million acres of upland and Pima cotton across the cotton belt. Cotton production is a strength of the agricultural south, a major economic engine in rural areas, and continued study of basic management practices is needed.

But why is another look at K fertilization of cotton needed? A review of the literature quickly shows that K sources (Howard et al., 1998a; Coker et al., 2009; Pervez et al., 2004; Oosterhuis and Howard, 2008), methods of K application (Coker et al., 2009; Howard et al., 1998b), K rate (Pervez et al., 2004), soil K (Cassman et al., 1989) and cotton cultivar effects (Gwathmey et al., 2009) have all been evaluated. A review of this published work leads to some conclusions about K fertilization of cotton:

- K deficiencies may be observed in fields that do not test low in soil K (Cassman et al., 1989)
- Foliar K may (Pettigrew et al., 1996; Howard et al 1998b) or may not (Coker et al., 2009) produce increases in lint yield (and/or quality)
- The impact of foliar K is affected by soil K levels and soil water (Cassman et al., 1989), and,
- New and emerging K sources for cotton need further study (Oosterhuis and Howard, 2008).

Basically, we know we need K for high-yield cotton production (especially when the cotton is irrigated), but we are not yet sure if current southern K soil tests accurately predict cotton response and yield, nor do we have definitive information about best practices for foliar K application for cotton. Additionally, K sources for cotton production are a topic of much interest for southern cotton growers, and the varying K sources potassium nitrate, potassium chloride, potassium sulfate and potassium thiosulfate (http://www.tessenderlo.com/binaries/LiquidVisions_Vol1Issue1_tcm9-5808.pdf) are always a topic of discussion at grower meetings.

Cotton cultivars are always changing, but in the past 5 years the adoption of new, high yielding cultivars has created a new uptick in cotton yield (Figure 1, below). There are documented differences in K partitioning due to cultivar type (Clement-Bailey and Gwathmey, 2007; Gwathmey et al., 2009). Differences in K partitioning are related to maturity groups, but are less likely to be found when soil test K is at or above sufficient levels. However, newer high yielding cultivars currently being planted in southern cotton fields have received little study as to K partitioning and use, and growers are reporting the presence of K deficiencies, especially in irrigated cotton with high yield goals.

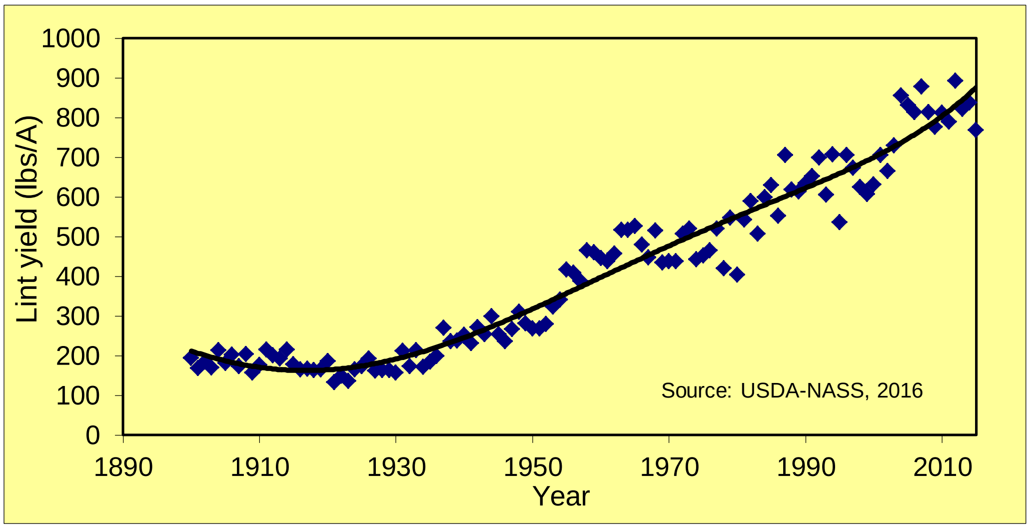
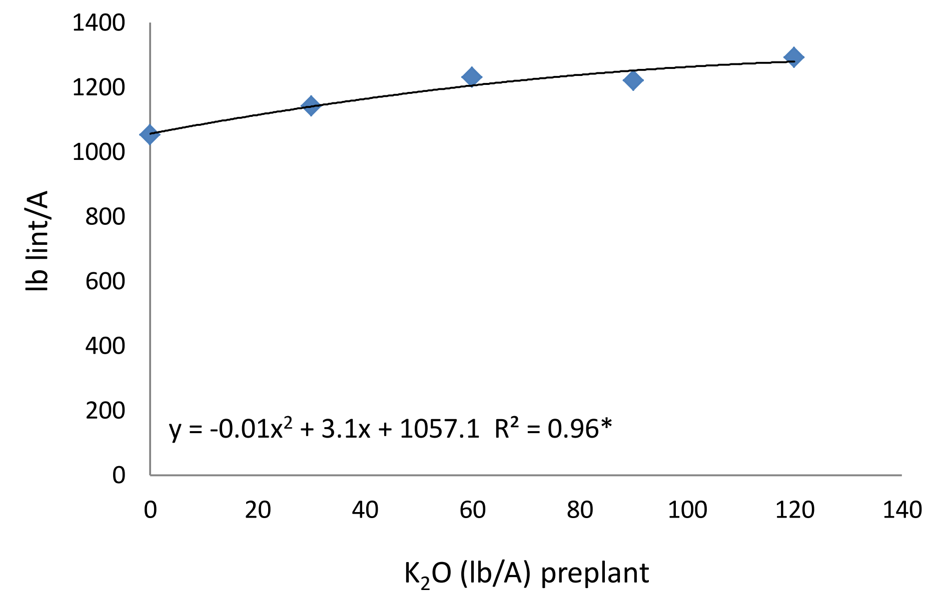


Figure 1. US Cotton yield, 1900 – 2016.

Our own research in Alabama has consistently shown that at-planting applications of K to fields that test at the ‘Medium’ or higher level of soil-test K result in greater lint yield (Figure 2, next page). Similar response to that shown in Figure 2 has been observed in all 3 years of study (2013 – 2015). In all three years soil test K in these studies ranged from 40 to 80 lbs K/A, (a ‘Medium’ soil test), with recommended fertilizer K_2O applications of around 40 lb/A. For these studies K was applied preplant as KCl at the rates shown in Figure 2.

Figure 2. Effect of K_2O Rate on Cotton Lint Yield, 2015.
Plant Breeding Unit, Tallasee, AL.



Because we were seeing consistent (although sometimes slight) yield increases to applications of preplant K, we wanted to explore the effectiveness of foliar K for cotton. This issue has been extensivly studied in Alabama (Mullins and Burmester, 1991; Mullins et al. 1997), and one could surmise that additional work with foliar application of K is no longer needed. However, new cultivars and new K sources mean that K use and partitioning by new cotton cultivars may be different, and thus new evaluations are warranted.

<u>Research Objectives:</u>

The Objective of this research proposal was to study the combined and separate effects of foliar K rate and source for high-yield cotton production, and to do this with new generation cotton cultivars. Specifically:

- Objective 1: Evaluate the K sources potassium nitrate, potassium carbonate, Tri-Fert K, and potassium thiosulfate in foliar K fertilizer programs.
- Objective 2: Evaluate K rate and cultivar effects, using new generation cultivars and older cotton cultivars, with Trisert K as the folliar K source.

<u>Methods:</u>

Objective 1:

The experiment was conducted in 2015 at the Field Crops Unit (FCU), located in Tallasee, AL. A field that tested 'Medium' for soil test K was used for this study (67 lb K/A), and the site was not under irrigation. Phytogen 499 WRF was the cotton cultivar, and all treatments were applied to 4 rows of cotton (36 inch row spacing, 40 feet in length) with four replications of each treatment. Treatments consisted of four K sources: 1) Trisert K, 2) potassium nitrate, 3) potassium acetate, and, 4) potassium carbonate, all at three K rates (8, 16 or 24 lbs K/acre in total – this is K, and not K_2O), applied as four split applications of 2, 4 or 6 lbs K weekly beginning 2 weeks after mid bloom (apprx 120 DAP – this was application 1). The 4 applications were applied at 10 gpa spray volume every other week at approximately pinhead square (134 DAP – application 2), 148 DAP – application 3, 162 through open boll (162 to 176 DAP – application 4). A zero K (no foliar K treatment) was also included. Treatments were not balanced for the N content in the KNO_3. Cotton was planted on June 5th 2015 and harvested on September 25th 2015.

Objective 2:

This experiment was also conducted at the Field Crops Unit in Tallasee, AL. The soil in this field had an initial soil test value of 62 pounds K/A, and the site was not under irrigation. Four cotton cultivars were used in this project, two new generation releases (Phytogen 499 WRF and Deltapine 1050 B2RF) and two older cultivars that were widely used in the past decade (Deltapine 90 and Deltapine 491). The intent of this work was not to compare yield across cultivars (newer should certainly outperform older) but to determine if the newer cultivars responded to K differently .

Treatments consisted of the four cotton cultivars and one foliar K source (Trisert K) and one K rate (40 lbs K_2O/acre in total (this is K_2O, and not K)), applied as four split foliar applications of 10 lbs K_2O bi-weekly beginning 2 weeks after mid-bloom in a 10 gpa spray volume. Zero K (foliar) treatments were also included for each cultivar. There were four replications of each treatment (4 cultivars x 2 foliar K (yes or no) = 8 treatments) for a total of 32 plots in the experiment. Each plot was 4 rows wide (36 inch row spacing) and 40 feet long. Cotton was planted on June 5th 2015 and harvested on September 25th 2015.

<u>Data Collection, Both Experiments:</u>

For both experiments, the following basic crop yield data was collected:
1) yield, 2) fiber quality and 3) plant damage as affected by treatment. Leaf samples were taken throughout the spray period, and those samples were analyzed for K content.

In addition to this data, K partitioning data was also collected, with whole plant samples (six per plot) collected at first square (apprx 46 DAP), early (first bloom; apprx 75 DAP), late bloom, (apprx 100 DAP) and open boll (approx 150 DAP). In each case samples were collected from the outer two rows of the four row plots, and samples were separated into appropriate plant parts as needed (leaves, stems, bolls). All plant tissue will be dried, weighed and analyzed for tissue K via standard methods. Note: This partitioning and K analysis are ongoing and not yet completed. Thus, those results will not be reported in this report.

Results:

Objective 1

There was not a significant K Rate x K Source interaction for lint yield, nor were the main effects of K Rate or K Source significant.

Table 1. Effect of foliar K sources on cotton lint yield, 2015.

K Source	Yield
	pounds of lint per acre
No foliar K	1195 a
Potassium carbonate	1068 a
Potassium acetate	1057 a
Trisert K	1002 a
Potassium nitrate	967 a
K Rate (lb K/A)	
0	1195 a
8	997 a
16	1002 a
24	1071 a
Linear regession	NS

Yield data was analyzed using means separation with an alpha of 0.05.

It appeared that some of the foliar K sources caused damage to the cotton leaves, as measured at 24 hours after spraying (Table 2). Damage was greatest early in the study, and at higher rates of K fertilization. For these burn ratings the interaction of K Rate and K source was never significant, although both main effects were.

Table 2. Relative burn of cotton leaves as affected by rating date, K Source and K Rate. All K applied as foliar products 24 hours prior to the rating dates shown.

K Source	Rating Date (24 hr after application)			
	July 16	July 30	Aug 13	Aug 26
	relative burn (1 – 5 scale, with a '1' for no damage)			
Control	1.0 c	1.0 c	1.0 a	1.0 a
Potassium Acetate	1.6 a	1.8 a	1.2 a	1.1 a
Potassium Carbonate	1.0 c	1.7 ab	1.2 a	1.0 a
Potassium Nitrate	1.1 bc	1.1 bc	1.0 a	1.0 a
Trisert K	1.4 ab‡	1.7 ab	1.1 a	1.0 a
K Rate (lb K/A)				
0	1.0	1.0	1.0 a	1.0 a
8	1.2	1.4	1.0 a	1.0 a
16	1.3	1.8	1.1 a	1.0 a
24	1.4	1.5	1.2 a	1.1 a
Linear regression	L†	Q	NS	NS

† Since K is a rate effect linear regression was used for the analyses – L: significant linear effect, Q: significant quadratic effect, NS: Not significant. Alpha of 0.05 for the significance of the regression equation.

‡If followed by the same letter (within each rating date) means are not significantly different from each other at an alpha of 0.05.

Objective 2

While there were differences in yield due to cultivar (Table 3, following page) the presence of the foliar K did not affect yield, nor was there a significant K Rate x cultivar interaction. These first-year results with foliar K supports the previous 3 years of work with different cultivars: older cultivars do not yield as well as new, but they do not appear to have differental use of K, as indicated by non-significant K Rate x K source interactions. Of course, K partition data from this foliar experiment may help to clarify this issue.

Table 3. Lint yield of cotton cultivars as affected by foliar K and cotton cultivar, Tallasee, AL, 2015. If followed by the same letter means are not significantly different from each other at an alpha of 0.05. The interaction of K Rate and Foliar K was not significant.

Cultivar	Lint yield (pounds/acre)
Phytogen 499	960 a
Deltapine 1050	881 a
Deltapine 491	764 b
Deltapine 90	692 b
Foliar K	
YES	806 a
NO	843 a

Further Work

Additional work should examine timing and rates of foliar K, as well as carrier volume. Some previous work with adjuvants has shown them to be useful (in boron studies) and that may be another area of exploration. Foliar K may be more useful on hhigher yield irrigated cotton, and that question should be explored as well.

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