VARIETY AND SOIL TEST POTASSIUM EFFECTS ON COTTON NUTRITION AND LINT YIELD

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Abstract

Strategies utilizing tissue and soil testing may help to achieve proper K fertility status for modern cotton varieties with wide ranging maturity. The objective of this research was to examine how different maturing cotton varieties performed across varying soil test K levels. A field experiment was planted in 2007 through 2009 utilizing Delta and Pine varieties: 444,445,454,455, and 555. Soil samples were collected prior to fertilizer N applications and leaf tissue K samples were collected at 2nd week of flower growth stage for all years. Soil test K level strongly influenced yield across varieties and the mid to full maturing variety responded best across all soil test K levels. A mid to full season maturing variety appeared to utilize K more efficiently than early maturing varieties at the 2nd week of flower growth stage, especially under limited soil K conditions. The use of accurate soil testing and leaf tissue K analyses at various growth stages may provide a producer with a better understanding of K uptake and utilization which could be beneficial in reaching the goal of proper K fertility.

Introduction

A better understanding of maturity group response to soil K availability could lead to more refined K fertilization management strategies. Cotton maturity groups vary in their determinacy and thus, their growing season length requirements. Due to the susceptibility of early maturing varieties to express visual K deficiency symptoms, there is speculation that greater soil test K is required to optimize production. Research investigations with regards to varying maturity and K management have not fully supported this theory (Mullins and Burmester, 1990; Pettigrew et al. 1996; Pettigrew and Meredith, 1997; and Pettigrew, 2003). Recently, Clement-Bailey and Gwathmey (2007) concluded that an early maturing variety may require greater K fertilization under no tillage management. Keino et al. (1995) did demonstrate the ability of an early maturing cultivar (DP20) to deplete soil solution K at a faster rate than a later maturing variety (DP90), while DP20 had a greater affinity for K^+ at low solution levels. Brouder and Cassman (1990) observed differences in root growth determinacy with "K-efficient" cultivars showing greater and prolonged root growth following peak bloom. Although numerous studies have been done comparing cultivars varying in maturity, there is a general lack of coinciding leaf tissue K^+ analysis. The objective of this study was to determine lint yield and leaf tissue K response of cotton varieties varying in maturity from early to mid to full season to varying soil test K^+ levels.

Materials and Methods

A study was conducted at the Mississippi State Plant Science Research Center, Mississippi State, MS from 2007 through 2009. The soil at the site was a Marietta (fine-loamy, siliceous, thermic Fluvaquentic Eutrochrept). Plots were 30 ft in length and cotton was planted in a 4 X 2 skip row planting with 38 in row spacing. The site was under conventional tillage in 2007 and no-tillage management in 2008 and 2009. Cotton was planted on 18 May, 2007, 7 May, 2008 and 1 June, 2009 at a rate of 4.3 seed/ft. Five varieties of Delta Pine Land Company cotton, which varied in maturity from early to mid to full season, were planted. The field was fertilized with UAN (32%) a rate of 120 lb N/acre. Fertilizer N was injected 8 in to the side of the row and 4 in deep and was applied as a split application (50 % at planting / 50% at early square). Pest and weed populations were scouted and managed according to university recommendations.

From 1998-2003, fertilizer K in the form of 0-0-60 was applied at 0, 50, 100, and 150 lb K/acre. The last fertilizer K application was in the fall of 2003 using K-Mag at a rate of 44 lb K/acre. The essential buildup of soil K in 2007 resulted in varying soil test K levels of K0 (174 lb K/acre), K1 (211 lb K/acre), K2 (229 lb K/acre), and K3 (260 lb K/acre). Varying soil test K levels, according to Mississippi Extension Service Soil Testing Lab recommendations, were classified as low K fertility for K0 through K2, and K3 was at a medium rating. Cotton varieties (DPL BG/RR) varying in maturity included 444(early), 445(early to mid), 454(mid), 455(mid), and 555(mid to full). Each treatment had four replications and were arranged as a complete randomized block design.

Measurements

Five recently matured leaves, typically 5 nodes from the terminal, were collected at the 2nd week of flower on 23 July, 2007, 22 July, 2008, and 3 August, 2009. Leaf samples were prepared using a dry ash procedure and K analysis by atomic absorption spectroscopy. Soil samples were taken all years at 0 to 6 in depths from each plot prior to planting and extracted using the Mississippi Soil Test Method (Raspberry and Lancaster, 1977). Cotton was harvested from the center two rows using a spindle picker. A sub-sample was taken from each plot, ginned separately, and overall lint yield was determined.

Results and Discussion

Rainfall

In 2007, 12.5 in of rainfall was received during the growing season with 3.5 in coming around the early flower growth stage. This was an exceptionally dry year compared to 2008 and 2009. In 2008, rainfall from planting to harvest was 26.7 in with 9.5 in received during the 3rd to 4th weeks of flower. In 2009, it was dry early and excessively wet late in the season. Rainfall received was 36 in during the growing season with 20 in falling in the weeks immediately prior to harvest.

Maturity Group Response to Soil Test K^+

In 2007, across soil test K levels, variety DPL 555 showed the greatest response at the highest soil test K level (Fig. 1). Across all other soil K levels, varieties were similar in response. Variety response to varying soil test K levels in 2008 is shown in Fig. 2. Variety 555 showed the greatest response at the highest soil test K level. Apart from DPL 454, a relationship between leaf tissue K and soil test K levels was evident. In 2009, as the data shows in Fig. 3, DPL 555 showed the greatest leaf tissue K response at the highest soil test K level. An observable trend for 2007 to 2009 recognizes that the mid to full season maturing variety responded better than the other varieties at the highest soil test K level. Critical leaf tissue K levels are known to fall between 0.9 and 1.2% (Baker et. al, 1992). In 2007 through 2009, all leaf tissue K values were below critical level status. The data shows a direct correlation between critical leaf K levels and soil test K for 2007 through 2009.

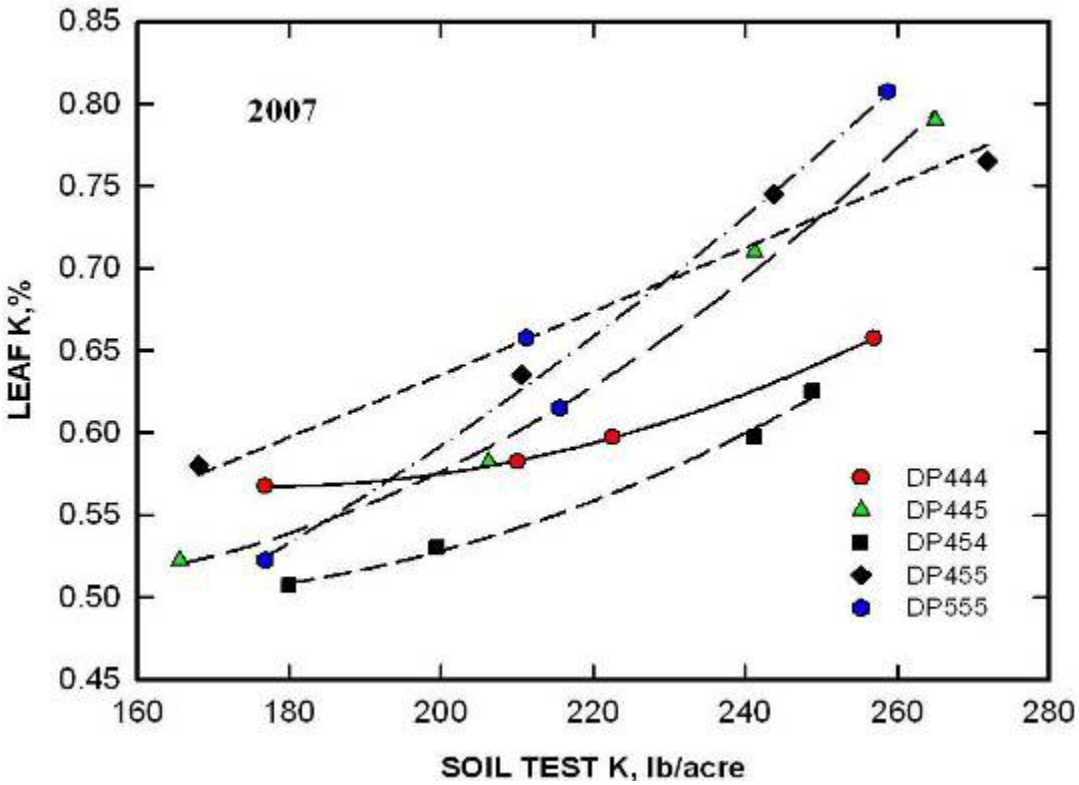

Figure 1. Leaf tissue K response in 2007 by varieties varying in maturity from early to mid-full season to varying soil test K.

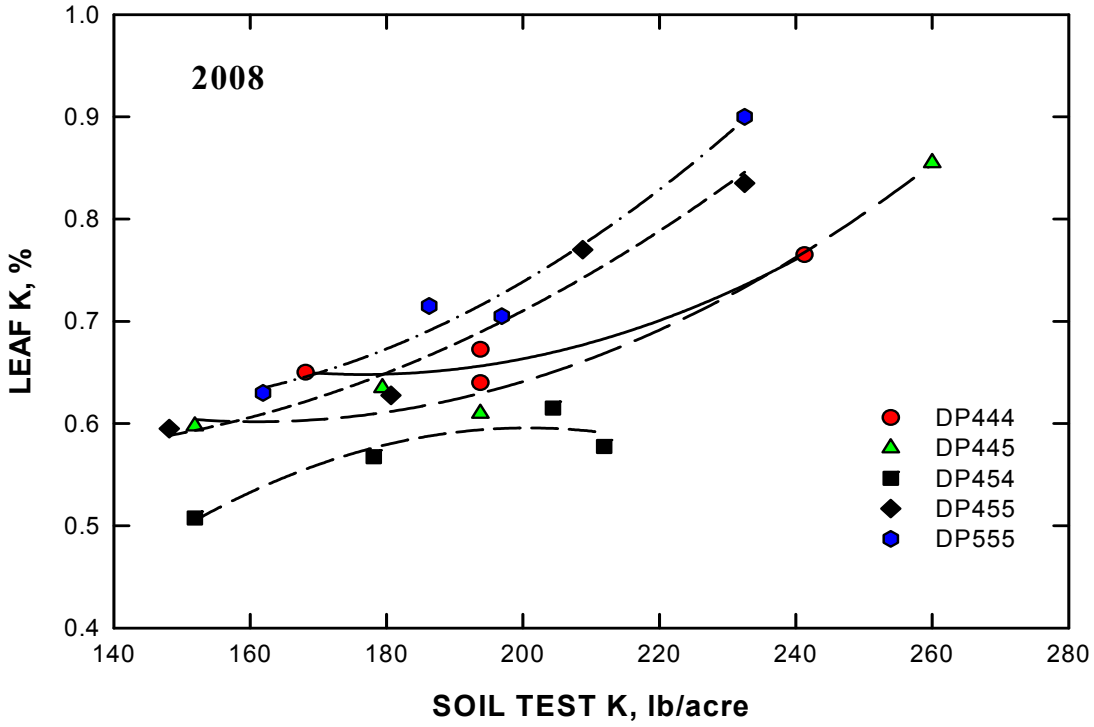

Figure 2. Leaf tissue K response in 2008 by varieties varying in maturity from early to mid-full season to varying soil test K.

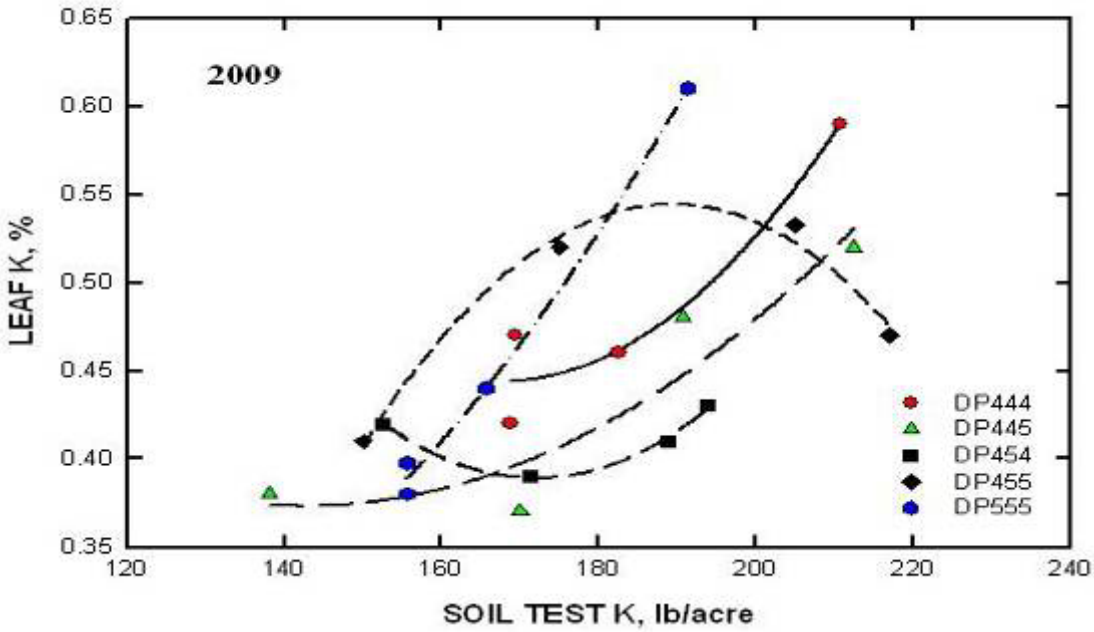

Figure 3. Leaf tissue K response in 2009 by varieties varying in maturity from early to mid-full season to varying soil test K.

Variety Cotton Yield Response to Soil Test K^+

In 2007, a similar yield response to increasing soil test K across all varieties was observed (Fig. 4). DPL 555 yielded the greatest when compared to other varieties at the highest soil test K level. In Fig. 5, a slight separation is evident with DPL 555 compared to other varieties. Yield responses were again similar across varieties and soil test K levels for 2008. In 2009, an extreme separation of the mid to full season maturing variety is shown in Fig. 6. Soil K depletion, as evidenced by a shift in soil test K to lower values each subsequent year, greatly affected yield across all varieties.

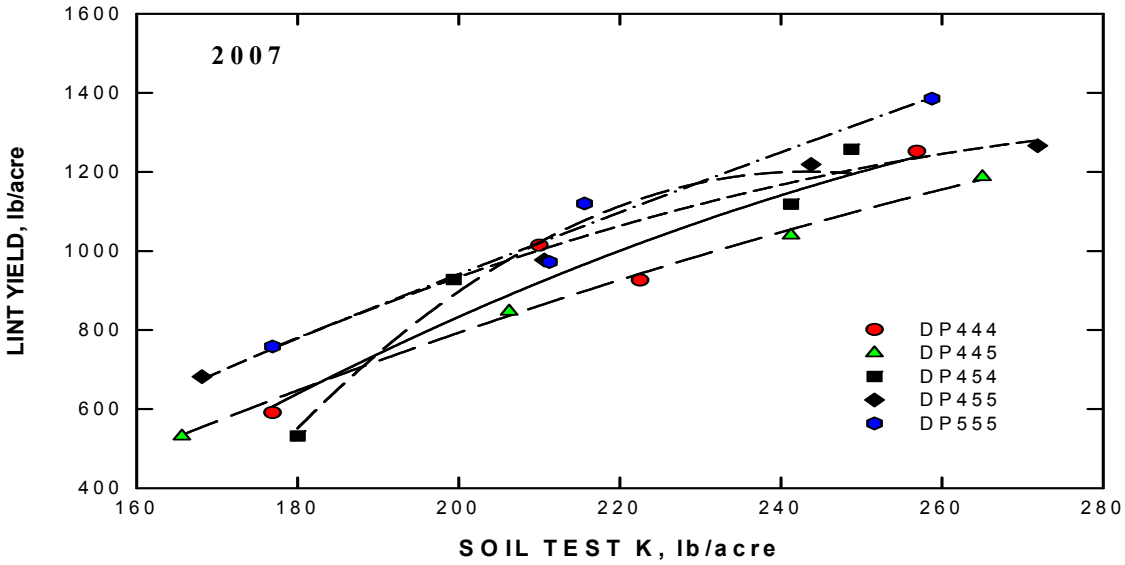

Figure 4. Lint yield response in 2007 by varieties varying in maturity from early to mid-full season to varying soil test K.

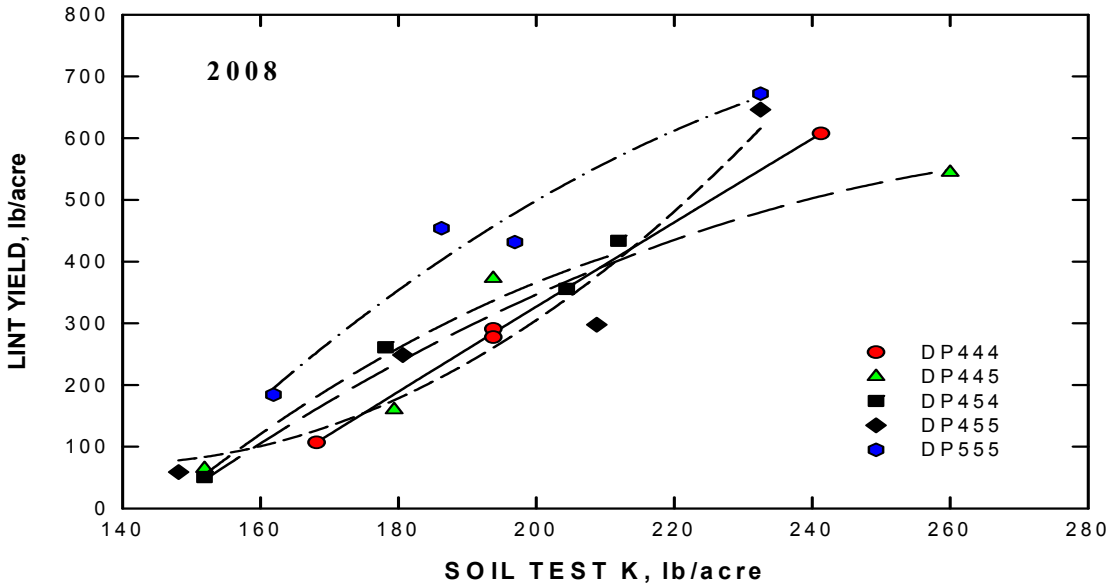

Figure 5. Lint yield response in 2008 by varieties varying in maturity from early to mid-full season to varying soil test K.

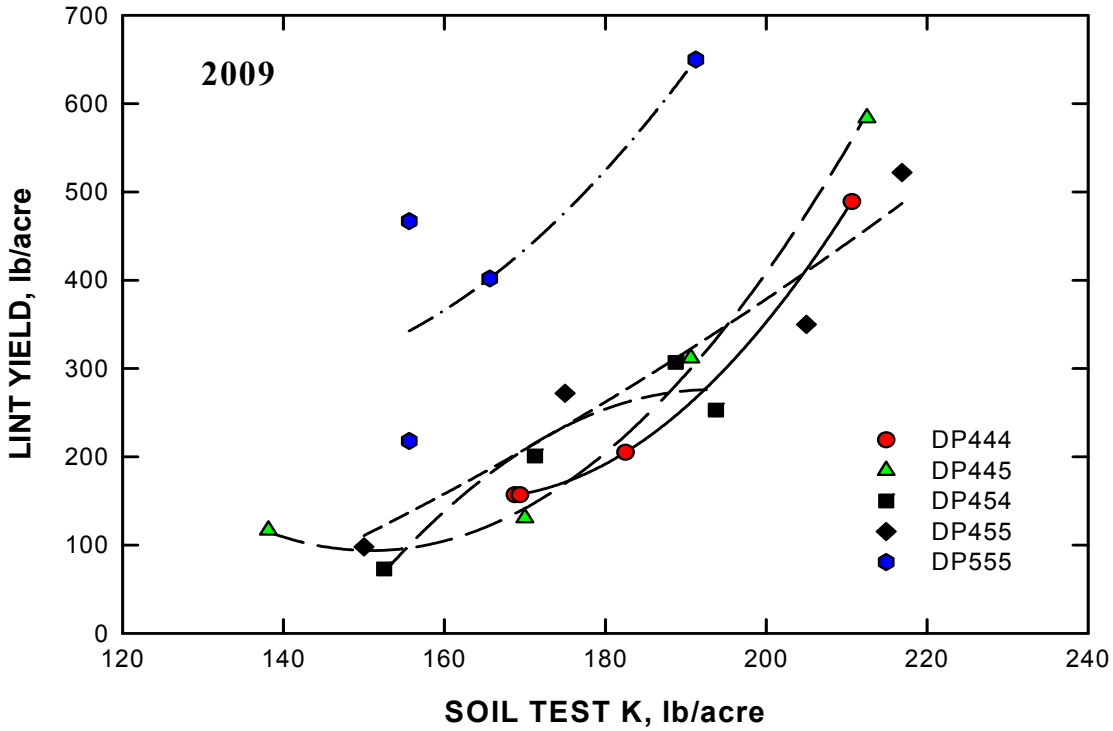

Figure 6. Lint yield response in 2009 by varieties varying in maturity from early to mid-full season to varying soil test K.

Conclusions

This study showed that soil K depletion directly influenced yield, and the responses of varying maturing cotton cultivars to soil test K levels were similar. Producers that choose to mine K run the risk of a dramatic decline in yield. The theory of an early maturing variety requiring more K for optimal production may be limited to a higher K fertility regime. The observable differences in cotton varieties shown by this research may be reduced under adequate K fertility conditions. A mid to full season maturing variety performed the best across varying levels of soil test K. This suggests that K uptake dynamics may differ for late maturing varieties versus early maturing varieties. More research must be conducted regarding variety cotton response to soil test K levels throughout the growing season. To properly characterize K utilization and uptake by variety, research must be conducted which addresses source-sink relationships at varying growth stages. A better understanding of the relationship between leaf tissue K and soil K has the potential to reduce fertilizer K cost, ultimately benefiting the producer.

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