MISSISSIPPI

No-Tillage Cotton Responds to Potassium Fertilization on High CEC Soils

By Jac J. Varco

Results of a Mississippi study indicate that potassium (K) requirements for cotton in no-tillage production may be greater than for conventional tillage cotton, especially on soils with high cation exchange capacity (CEC). Improved water retention with no-tillage as well as the effect of K on water use efficiency may be at least partially responsible for the effects observed in this research.

Implementation of no-tillage practices for cotton has prompted questions regarding the application of fertilizer K due to its limited-mobility in soil. Fertilizer K is commonly broadcast and incorporated into the soil with tillage. Surface placement without incorporation in no-till and reduced-till conditions may lower the effectiveness of K fertilization due to soil test K stratification in the shallow surface soil. Additionally, cotton is primarily a tap-rooted crop, which may limit surface soil feeding.

A shift towards higher soil test levels to maximize profitability may be required for no-till conditions. Modern cotton cultivars grown from the Midsouth to the Southeast are fast-fruiting, high-yielding, and early maturing. Since total K requirements of modern varieties have not decreased, the K uptake period has been compressed. This may require higher soil test K levels to meet the period of high demand.

Potassium deficiency symptoms in modern varieties are often observed in the upper canopy (immature leaves) rather than in older mature leaves, possibly due to a heightened demand by developing bolls. The expression of symptoms progresses from flowering through boll formation.

A K response study was begun in 1992 on a Leeper silty clay loam soil at the Mississippi State University (MSU) Plant Science Research Center to determine the validity of current soil test recommendations for early

Cotton leaves showing upper canopy K deficiency.

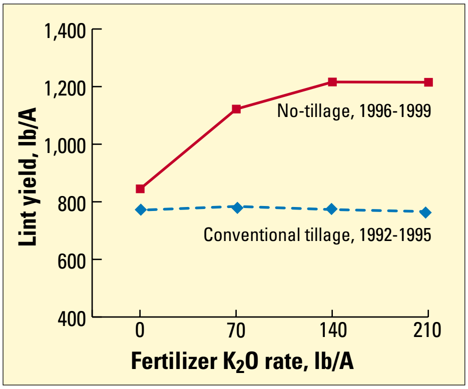

Figure 1. Cotton lint yield response to fertilizer K rate as influenced by tillage.

maturing cotton varieties. To provide a wide range in K availability, rates of 0, 70, 140, and 210 lb K_2O/A were broadcast prior to planting each year. From 1992 through 1995, fertilizer treatments were incorporated with tillage. From 1996 through 1999, strict no-tillage production practices were used. Tillage for 1992 through 1995 included fall subsoiling and hipping followed by rehipping in the spring after fertilization and bed knockdown and smoothing with a do-all just prior to planting. For all treatments and years, a rate of 120 lb N/A was applied as a 50/50 split at planting and early squaring. Cotton variety DES 119 was planted in 1992 through 1995, and Suregrow 125 was grown in 1996 through 1999.

The average K soil test prior to fertilization in 1992 was 157 parts per million (ppm)...314 lb/A, Mississippi Lancaster method...and was categorized within the upper limit of the medium soil test category. (The Lancaster method extracts approximately 15 to 20 percent more K than Mehlich III.) At this level, a low probability of a response would be predicted according to MSU Extension Service recommendations. Lint yield did not respond to applied K with conventional tillage (**Figure 1**).

In contrast, a dramatic yield response to applied K was found with no-tillage. Maximum agronomic yield was predicted at a rate of about 172 lb K_2O/A, using the four-year average for no-tillage. On this soil, Lancaster-extractable K would have to be near 218 ppm (436 lb/A) to optimize yields. Year-to-year variation in yield was greatest with conventional tillage, and increasing K rate with no-tillage appeared to reduce this variability in yield. Most notable is the fact that growing season rainfall was less for 1996 through 1999 (1996, 18.6 in.; 1997, 16.7 in.; 1998, 12.8 in.; 1999, 11.8 in.) compared to 1992 through 1995 (1992, 20.5 in.; 1993, 15.2 in.; 1994, 26.2 in.; 1995, 17.3 in.).

Although direct comparisons within years between tillage systems are not possible, the results indicate that K was not a limiting

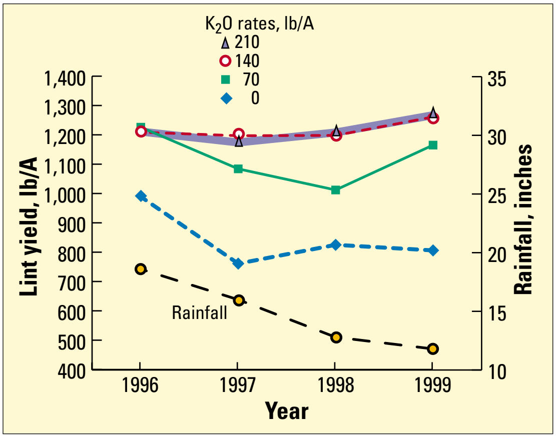

Figure 2. No-till cotton lint yield as influenced by fertilizer K rate and rainfall each year.

factor at the initial soil test levels with conventional tillage. For no-tillage, however, the results indicate that K was a limiting factor and that higher soil test levels may be required for silty clay loam soils with a CEC higher than 25 $cmol_c$/kg (meq/100 g). The observed response with no-tillage could be due at least partially to benefits such as increased water availability, which may have improved the marginal productivity of fertilizer K. The yearly trend in yield for no-tillage relative to K rate and growing season rainfall is shown in **Figure 2**. A decline in yield was evident for the 0 and 70 lb K_2O/A treatments with a decline in growing season rainfall,

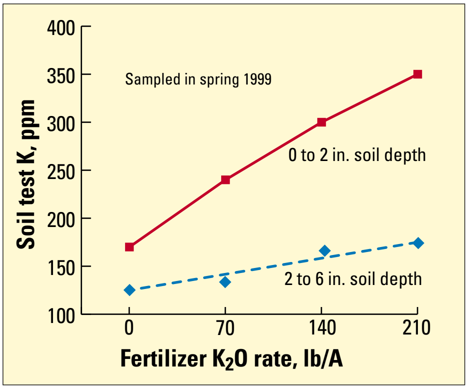

Figure 3. Soil depth effects on retention of applied fertilizer K under no-tillage conditions. (Soil test K is Lancaster-extractable.)

while at the two greatest rates, yield appeared to become less affected by year-to-year variation in rainfall (i.e. moisture deficits). Thus, increased K availability appears to have improved water use efficiency.

Vertical stratification of applied fertilizer K was apparent in this study after adoption of no-tillage practices (**Figure 3**). Soil test K increased the greatest in the shallow 0- to 2-in. depth. Only a slight increase was apparent in the 2- to 6-in. depth. Surface deposition of K from crop residues would also contribute some to this effect due to the elimination of tillage. Due to the high CEC (greater than 25) and mineralogy, this soil has a high capacity to adsorb K and limit its movement. Although leaching would not be expected on this soil, the high shrink-swell potential could cause some movement of surface soil into cracks formed during dry periods.

Results of this study suggest that K requirements for no-tillage cotton may be greater than for conventional tillage cotton, especially on high CEC soils. Improved water retention with no-tillage as well as the effect of K on water use efficiency may at least be partially responsible for the effects observed in this study. BC

Dr. Varco is Professor of Soil Fertility in the Plant and Soil Sciences Department, Mississippi State University. E-mail: jvarco@pss.msstate.edu

In Memory of Dr. Larry C. Bonczkowski, 1953-2000

Dr. Larry C. Bonczkowski, a well known agronomist and dedicated leader in fertilizer industry programs, passed away June 30, 2000. From December 1993 until his untimely death, he served as Manager, Agronomy Services, for Agrium U.S. Inc. in Denver, Colorado. Previously, he worked for Growmark, Inc. in Illinois and for Great Salt Lake Minerals Corporation.

In his professional career, Dr. Bonczkowski was responsible for providing technical agronomic information to staff and customers, delivering dealer and farmer meetings, conducting training programs, facilitating research and development programs, serving as liaison with land-grant universities, and participating at various regional and national events.

A native of Madison, Kansas, Dr. Bonczkowski grew up on the family farm and attended Kansas State University. After receiving his M.S. degree in 1977, he joined the Cooperative Extension Service in Kansas as Northeast Area Crop Protection Specialist. He completed his Ph.D. degree in 1989. Dr. Bonczkowski became a highly respected authority on chloride nutrition of wheat and other crops and later was active in addressing issues related to heavy metals and fertilizers.

He was a Certified Professional Agronomist and an active member of the American Society of Agronomy and the Soil Science Society of America. Also, he was a member of the Ag Retailers Association, the Fluid Fertilizer Foundation Board of Directors, and the Program Committee of the Great Plains Soil Fertility Association. Dr. Bonczkowski served on committees of The Fertilizer Institute and the Program Advisory Group of PPI.

A memorial fund was established at Kansas State University to provide an annual scholarship to a graduate student in soil fertility. Dr. Bonczkowski is survived by his wife, Patty, two sons, his mother, and a brother. BC