NEWS & VIEWS

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Potassium Fertilization Pays in Conservation Tillage Systems

COTTON requires potassium (K) throughout the growing season and accumulates K in amounts comparable to nitrogen (N): 11 to 15 lb of K for every 100 lb of lint produced. Potassium plays an important role in plant water relationships, growth of new tissues, photosynthesis, translocation of carbohydrates and sugars, and enzyme activation. A shortage of K can lead to greater drought susceptibility, increased disease susceptibility, reduced N use efficiency, decreased yield, lower lint quality, and lost farm profitability. Cotton was reported to be the crop most sensitive to K deficiency compared to vetch, corn, wheat, and soybeans in a long-term Alabama study (Cope, 1981).

The uptake and distribution of K in plant parts during the season are illustrated in **Figure 1**.

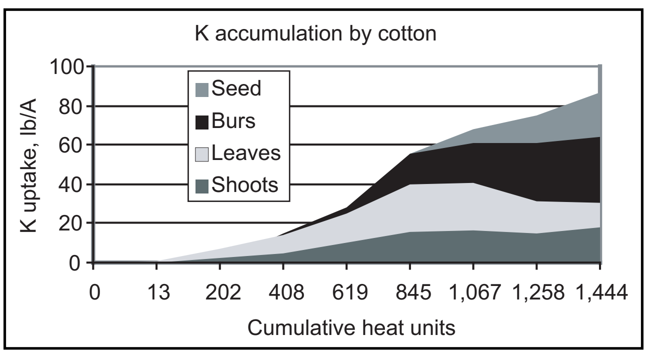

Figure 1. Cotton K uptake and distribution with plant maturity. **(Data courtesy of G.L. Mullins, Virginia Tech. Univ. —Source: Mullins, G.L., and C.H. Burmester. 1990. Dry matter, nitrogen, phosphorus, and potassium accumulation by four cotton varieties. Agron. J. 82:729-736.)**

The peak K uptake rate in cotton occurs about 60 to 80 days after planting and can exceed 3 to 4 lb/A/day. This period coincides with flowering and rapid reproductive growth and a decline in root growth. This decline in root growth during high demand emphasizes the importance of K uptake and storage in the stems, leaves, and petioles prior to fruiting. By maturity, 55 to 60 percent of the accumulated K can be found in the bolls (burs). At maturity, about 20 percent of the K is found in the seed and the lint. Potassium is the most abundant cation in the lint.

Auburn University research showed that the concentration of K increases in the burs with maturity, while it declines in the leaves and stems (**Figure 2**). If the K concentration in the burs (bolls) is not increased by translocation from stems and leaves, it is likely that

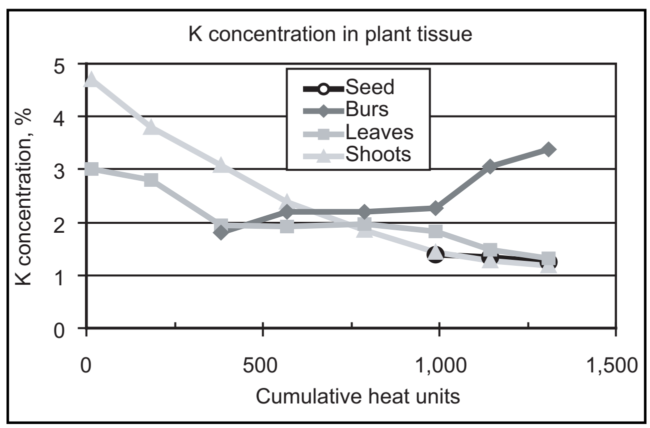

Figure 2. Cotton K concentration in plant tissues with plant maturity. **(Data courtesy of G.L. Mullins, Virginia Tech. Univ. —Source: Mullins, G.L., and C.H. Burmester. 1990. Dry matter, nitrogen, phosphorus, and potassium accumulation by four cotton varieties. Agron. J. 82:729-736.)**

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developing seed and lint could suffer, resulting in lower yields.

Recent Research Results

Auburn University—Conventional Tillage

Potassium nutrition research on a silt loam soil in the Limestone Valley of north Alabama (Mullins et al., 1999) showed that one could expect excellent returns to K fertilization on low to medium K soils (**Table 1**).

Table 1. Net return to K fertilization by conventional tillage dryland cotton on a silt loam soil in north Alabama.

Soil test K rating	Fertilizer K applied, lb K_2O/A/yr	Average lint yield increase with K, lb of lint/lb of K_2O applied	Net return to K, $/A
Low	90	2.7	108
Medium	60	2.0	49

In this example , and the others that follow, we assumed that K_2O costs $0.15/lb, application cost is about $4.50/A, and cotton lint is valued at $0.52/lb.

In responsive years, K fertilization increased yields by as much as 450 lb lint/A on this low K soil. The researchers reported that the optimum soil test K level on this soil was 250 lb/A Mehlich 1 extractable K.

Mississippi—USDA-ARS Conventional Tillage

Research in the delta of Mississippi showed that K increased cotton lint yields (averaged across eight genotypes) by 108 lb/A/yr on a medium K fine sandy loam soil testing 209 lb/A Lancaster extractable K (Pettigrew, 1997.)

There was only one K rate used in the study (120 lb K_2O/A), so we do not know if a similar response would have been observed at a lower K rate. Assuming the same K and application costs as in the Alabama research example, the yield response to K fertilization in this Mississippi research would result in a net return of over $33/A on this soil testing medium in extractable K.

Mississippi State University No-Tillage Study

No-till research conducted on a silty clay loam (Varco, 2000) soil in Mississippi, which had 314 lb/A of Lancaster extractable K, showed that K increased lint cotton yields and increased net returns (**Table 2**).

Table 2. Net returns to K by dryland cotton under no-tillage production on a silty clay loam soil in Mississippi.

K rate, lb K_2O/A	Lint yield increase, lb/A	Lint gain with K, lb of lint/lb of K_2O	Net return, $/A
70	277	3.96	129
140	371	2.65	167
210	370	1.76	156

The 140 and 210 lb/A K_2O rates enabled the cotton to withstand drought stress better than the moderate 70 lb/A K_2O rate. Yields declined more sharply under the moderate K rate during drought stress (less than about 16 in. of rainfall during the growing season) compared to the higher K rates. The higher K rates also reduced the coefficient of variation across years, which could potentially mean greater yield stability and economic stability for farmers.

University of Tennessee No-Tillage Study

No-till research in west Tennessee on loessial (wind-blown) silt loam soils showed that the optimum Mehlich 1 extractable K level varied among the three soils studied (Howard, 2001). Research results indicated that the past critical level (level at which the probability of a cotton response to K addition is low) of 160 lb/A Mehlich 1 extractable K should be raised to between 250 and 280 lb/A for current cotton production systems and varieties (**Figure 3**).

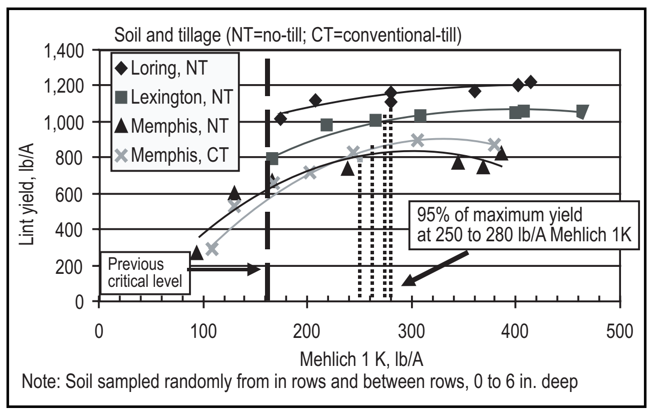

Figure 3. Cotton response to K fertilization in west Tennessee shows need for a higher critical (optimum) Mehlich 1 soil test K level. (Source: Howard, D.D., M.E. Essington, R.M. Hayes, and W.M. Percell. 2001. Potassium Fertilization of Conventional- and No-Till Cotton. J. Cotton Science 5:197-205.)

An increase in the soil critical level to 250 to 280 lb/A is consistent with the Alabama research cited above, using the same soil test K extractant. The Tennessee researchers reported that the K rate recommended on loessial silt loam soils in west Tennessee may also need to be increased by 30 to 60 lb of K_2O/A based on their results. Potassium fertilization in this study, as in the other three studies cited above, provided excellent net returns (**Table 3**).

Conclusion

Potassium fertilization of cotton is an attractive economic practice, even at current cotton prices. On soils testing medium or lower in extractable K in many southern states, farmers might expect the cotton lint increase per pound of K_2O applied to range from 1.31 to

Table 3. Net return to K by dryland cotton under conventional (CT) and no-tillage (NT) production on loessial silt loam soils in west Tennessee.

Soil and tillage (Initial Mehlich 1 soil K)	K_2O rate, lb/A	Average lint yield increase, lb/A	Lint increase per lb of K_2O, lb/lb K_2O	Net return to K_2O, $/A
Memphis, CT (90 lb/A)	25	243	9.72	118
	50	369	7.38	180
	75	434	5.79	210
	100	541	5.41	262
	125	612	4.90	295
	150	583	3.89	276
Memphis, NT (82 lb/A)	25	337	13.50	167
	50	408	8.16	200
	75	476	6.35	232
	100	478	4.78	229
	125	510	4.08	242
	150	560	3.73	264
Lexington, NT (180 lb/A)	25	185	7.40	88
	50	212	4.24	98
	75	243	3.24	111
	100	256	2.56	114
	125	263	2.10	114
	150	267	1.78	112
Loring, NT (202 lb/A)	25	99	3.96	43
	50	94	1.88	37
	75	144	1.92	59
	100	150	1.50	59
	125	183	1.46	72
	150	197	1.31	75

13.5 pounds. The net returns to K fertilization at these soil test K levels ranged from a low of $33/A to $295/A in the studies reported here.

In much of the Cotton Belt, there has been an increase in the percentage of cotton acreage using no-tillage or conservation-tillage systems. The research results cited in this report indicate excellent economic responses to surface broadcast (no incorporation) K fertilization are likely in conservation tillage systems on low to medium K soils. Recent no-till studies in Tennessee and Mississippi raise questions about "high" soil test K levels, since cotton yields continued to increase in response to K fertilization at soil test K levels previously considered as "high**." Clearly, many cotton farmers have a great opportunity to benefit from a sound K fertilization program, based on site-specific soil tests.** ■

References

Cope, J.T., Jr. 1981. Effects of 50 years of fertilization with phosphorus and potassium on soil test levels and yields at six locations. Soil Sci. Soc. Am. J. 45:342-347.

Mullins, G.L., G.J. Schwab, and C.H. Burmester. J. Produc. Agric. 12:434-440. 1999.

Cotton response to surface applications of potassium fertilizer: a 10-Year Summary.

Pettigrew, W.T. 1997. Dry matter production, nutrient uptake, and growth of cotton as affected by potassium fertilization. J. Plant Nutrition 20:531-548.

Varco, J.C. 2000. No-tillage cotton responds to potassium fertilization on high CEC soils. Better Crops 84(4):21-23.

Howard, D.D., M.E. Essington, R.M. Hayes, and W.M. Percell. 2001. Potassium fertilization of conventional- and no-till cotton. J. Cotton Science 5:197-205.

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