by Dr. D D. Howard

Evaluating Soil Fertility Production Practices for No-Till Cotton Fertilization

Researcher explores effects of starter, nitrogen, phosphorus, and potassium on cotton yields in different placement scenarios.

Summary: *The West Tennessee studies described in this article suggest that fertilization practices for no-till (NT) cotton may be more flexible than for other higher residue, reduced tillage systems. Starter solutions containing either 11-37-0 or calcium nitrate boosted NT yields. Broadcasting the primary plant nutrients NPK was effective for increased NT yields. An additional 30 to 60 lbs/A of K2O was needed to produce NT yields comparable to conventional-till (CT) yields. Foliar K applications buffered to pH 4.0 were also effective in providing supplemental K and increasing lint yields on medium extractable K soils.*

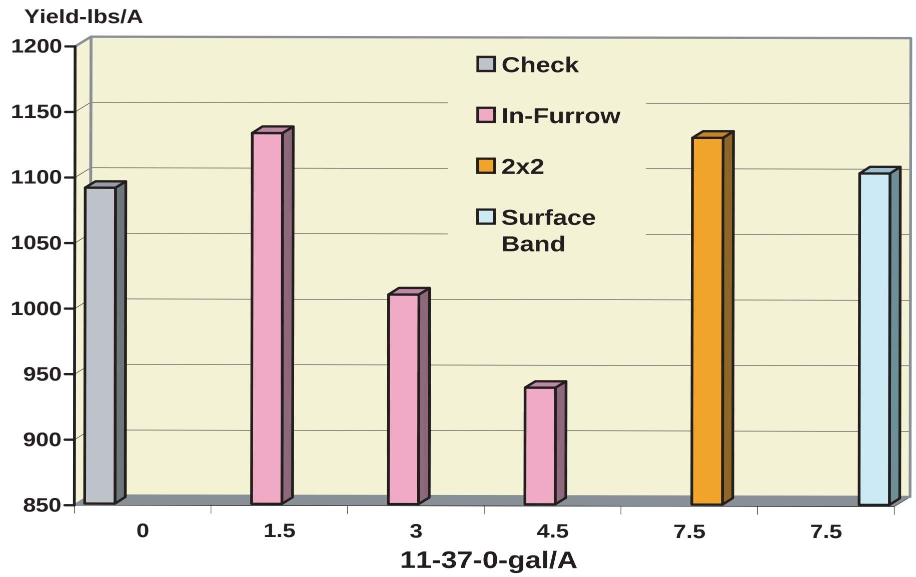

Figure 1. Effect of starter (11-37-0) application on NT cotton yield, grown on a Loring silt loam at Milan, TN, 1992-1993.

Nutrient efficiency for crop production is stressed more today primarily to maximize fertilization efficiency for improving producers' profitability and to reduce any possible effects on the environment. Production practices promoting fertilizer use efficiency include timeliness of nutrient application, method of application, and nutrient sources.

Starter on cotton

Yield increases from starter applications for NT systems are influenced by a number of factors such as weather at planting, nutrient combination of the starter, and placement method. Frequently used placement methods include 2 by 2 banding (applying starter 2 inches to the side and 2 inches below the seed at planting), surface banding (applying starter over the planted row as a 4-inch band), and in-furrow (IF) applications (in direct contact with seed). A major concern of the IF application is the possibility of ammonium toxicity affecting germination. Ammonium toxicity has been reported to result from a temporary calcium deficiency. Therefore, IF starters for cotton production should contain nitrate N.

Research conducted in Tennessee indicates that the rate of fluid 11-37-0 applied IF as a starter should be limited to 1.5 gal/A. In this research, plant populations (not reported) and yields were reduced from IF applications of 3 and 4.5 gal/A of 11-37-0 compared to IF applications of 1.5 gal/A or banding 7.5 gal/A 2 by 2 or surface banding 7.5 gal/A (Figure 1).

Applying starters IF is an easy and convenient method for cotton production. Most producers have a liquid IF application system mounted on their planter for fungicide and insecticide applications. The need is for a material that can be applied IF with minimal detrimental effects on the germinating seed and is compatible with fungicides and insecticides.

Applying liquid calcium nitrate appears to meet this criterion. Research conducted with calcium nitrate solution as an IF starter for NT cotton indicated that the solution could be applied over a wide application range. IF applications of 2 to 8 gal/A of $Ca(NO_3)_2$ increased yields when compared with the check. Yield increase on a Loring soil was comparable with the yield from IF applying 1.5 gal/A of 11-37-0 (Table 1). The wide application range (allowing for possible calibration errors), plus the increased yield, makes calcium nitrate solution a feasible IF starter material. The primary disadvantage for calcium nitrate would be for those situations where P and/or K is needed as a starter component.

N fertilization

Nitrogen fertilization of cotton affects yield, earliness, and lint quality. For perennial cotton, applying optimal N is essential and may differ within a production area due to climatic and soil differences. An optimal N rate should maximize yields, while excessive or inadequate N applications may reduce cotton yields. High N fertilization may produce excessive vegetative growth, delaying maturity and harvest. These conditions may reduce yield and lint quality during years of early frost or prolonged Fall rain. Crop maturity is a critical production consideration for cotton producers along the northern edge of the U.S. Cotton Belt. Nitrogen deficiency causes premature senescence and reduced yields.

Research conducted on three loess–derived soils indicates that broadcasting 60 to 90 lbs/A of N was sufficient for NT cotton production (Table 2). Winter covers for the three soils were winter weeds on the Loring silt loam, winter wheat on the Lexington silt loam and corn stover on the Memphis silt loam. In this research, increasing N rates (30 to 120 lbs/A) were either broadcast as ammonium nitrate (AN) or injected as urea-ammonium nitrate (UAN) solution.

Table 1. Effect of starter sources and application methods on NT cotton produced on Loring silt loam and Collins silt loam at Milan and Jackson (1994-1997).

Treatment	Placement	Broadcast N	Broadcast P_2O_5	Starter N	Starter P_2O_5	Yield Loring	Yield Collins
		lbs/A					
Check		80	40	0	0	982	1,116
$Ca(NO_3)_2$	IF	78	40	2	0	1,116	1,206
$Ca(NO_3)_2$	IF	76	40	4	0	1,131	1,193
$Ca(NO_3)_2$	IF	72	40	8	0	1,141	1,190
$Ca(NO_3)_2$	IF	68	40	12	0	1,073	1,133
11-37-0	SB	70	7	10	34	1,188	
11-37-0	IF	79	35	2	7	1,138	

IF = in furrow SB = surface band

These materials were applied immediately after planting. Injecting UAN reduced earliness, reduced ratio of first picking to total lint yields in certain years (all characteristics of excessive N availability), and did not improve yields, which contrasts to research conducted in other states. This research indicates that N immobilized by surface residues was small since yield differences between the two application methods (broadcasting or injecting) were not significant. This was surprising when compared with reduced yields resulting from surface N applications for NT corn production. Based on these data, broadcast N application for NT cotton may be effective with low amounts of surface residues on the loess-derived soils.

Additional N research was conducted, evaluating N application rates and application timing for CT and NT cotton produced on loess-derived soils. N rates of 40, 48, and 80 lbs/A were broadcast at planting. An additional 32 lbs/A was sidedressed to the cotton approximately four weeks after planting on those plots receiving 48 lbs/A of N broadcast at planting. Splitting N applications increased NT yields on two of the three soils when compared to broadcasting all of the N at planting. The response to sidedressing was limited to NT production. Broadcasting only 40 lbs/A of N lowered CT and NT yields in five of six site-years.

Research conducted in 1999 and 2000 on a Loring silt loam at Milan indicated that 90 lbs/A of N was optimum for ultra-narrow row cotton (Figure 2). This rate is slightly higher than the current N recommendation for cotton production.

Potassium fertilization

Fast-fruiting cotton cultivars have exhibited K deficiencies beginning at bloom. Foliar applying low K rates three to four times, beginning at bloom, partially corrects these deficiencies. These fast-fruiting cotton varieties may exhibit K deficiency on new leaf growth in the top third of the plant rather than on the older mature leaves. Soil and foliar applied K was examined on three soils of varying extractable K. Mehlich-I extractable K was high on two soils and low on the third. Both CT and NT production systems were used.

Four-year average CT yields produced

on a high extractable K Loring silt loam were unaffected by soil applied K, while CT yields on a high K Lexington silt loam were increased by broadcasting 30 lbs/A of K_2O. NT cotton yields on both soils were increased by broadcasting 60 lbs/A of K_2O, which was higher than the currently recommended K fertilization rate. Foliar K applications did not increase yields on these two high K soils.

Four-year average CT and NT yields on the low extractable K Memphis silt loam were increased by broadcasting 120 lbs/A of K_2O. This fertilization rate was the highest used in the research and was higher than that recommended for cotton production. Foliar K applications increased yields for both tillage systems on this low extractable K soil.

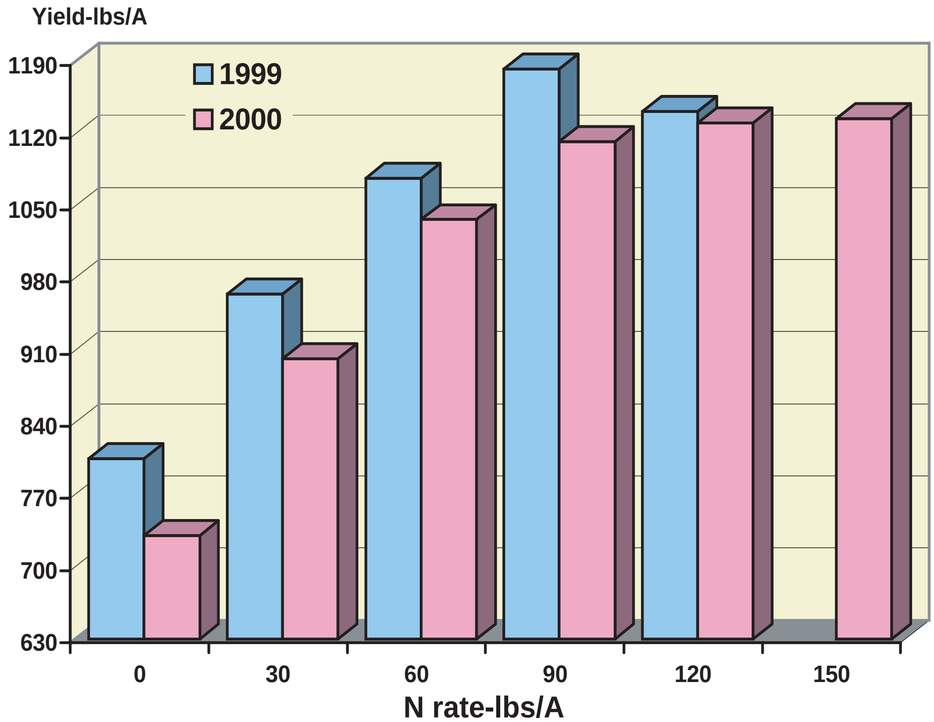

Figure 2. Effect of varying nitrogen rates on yield of ultra-narrow row produced cotton.

Table 2. Nitrogen rate and method of placement for NT cotton production on three silt loam soils at Milan, Jackson, and Ames Plantation

N rate	Loring*		Memphis**		Lexington**	
lbs/A	B	I	B	I	B	I
	lint yield (lbs/A)					
0	660		733		970	
30	900	878	866	904	1,229	1,207
60	1,143	1,164	946	934	1,371	1,248
90	1,111	1,280	1,044	932	1,356	1,342
120	1,145	1,301	1,023	954	1,365	1,232

* 1994-1997
** 1996-1997
B = broadcast
I = injection

Foliar K fertilization

Foliar K fertilization of cotton was evaluated as a supplement to soil K for increasing yields. Effects of solution pH on K uptake and yields were also evaluated in other studies. An acid buffer surfactant was included in the studies and increased K uptake on a Lexington silt loam. K concentration increased in leaves collected one, three, and seven days after foliar K application of potassium nitrate plus an acid buffered surfactant (pH 5.5). Yields were also increased by these foliar K applications.

Additional research included varied solution pH levels (unbuffered at pH 9.0 and buffered solutions at pH 6.0 and 4.0). Buffering to pH 4.0 increased four-year average lint yields compared with yields when the foliar solutions were buffered to high pH levels. Buffering foliar solutions to an acid pH range improved foliar K uptake and yields.

Phosphorus fertilization

Surface broadcasting P appeared to be an effective application method for NT cotton on a low P testing Loring silt loam. Broadcasting 40 lbs/A of P_2O_5 was sufficient for improved yields. A combination of broadcasting 40 lbs/A of P_2O_5 plus 60 lbs/A of K_2O produced highest yields over five years on this low P testing soil.

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