EVALUATING COTTON YIELD RESPONSE TO RESIDUAL NITROGEN IN A CORN/COTTON ROTATION SYSTEM

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Abstract

The corn acreage in Mississippi has grown to 800,000 acres and reached a high of 940,000 in 2007, with a record grain yield average of 165 bu/acre across the state in 2012. In the Delta region, grain yields have exceeded 250 bu/acre on some farms cases where irrigation has been available. In just the last ten years cotton production has decreased from 1.62 million acres in 2001 to 290,000 acres harvested in 2009. The 2004 crop produced an all-time record yield of 1,024 lb lint/acre on 1.1 million acres. Since 2007, cotton acreage dropped dramatically in the Mid-South as grain crop acreage increased due to excellent prices for those crops while cotton prices declined along with world demand. As the corn acreage increased, the opportunity for rotations rose significantly. Cotton yield increases due to rotation have averaged 10 to 18% with higher benefits observed in drier years in the Mississippi Delta. The yield advantage to cotton in multi-crop systems has been attributed to multiple factors that have included: better soil tilth, improved water infiltration, increased organic matter content, depressed nematode populations following corn, as well as benefits due to rotation of herbicides. This last factor continues to gain in importance as glyphosate-resistant weeds become more prevalent and producers shift back to residual herbicides. In many situations, cotton yields have been maintained following corn with less total fertilizer N required. However, little information has been available on how much N rates could be reduced for cotton following corn, how much residual N is available to the subsequent cotton crop, and what effect rainfall totals and distribution have on biological processes affecting residual N. Excess N can and has led to increased vegetative growth and has reduced both lint yield and lint quality in some years. Efficient utilization of available N can reduce the overall cost of production while reducing the potential release of nutrients from the field into waterways and streams.

A multi-year study was initiated in 2004 at the Delta Research and Extension Center with one-half of the research field planted to corn each year and the other half planted to cotton. In the initial study, fertilizer N rates for corn ranged from 120 to 300 lb N/acre in 30-lb increments and were applied as urea-ammonium nitrate solution (32% N) with 120 lb N/acre applied prior to planting (PP) and the remainder applied as a sidedress (SD) application at the V5 to V6 growth stage. Also, in the initial study, potassium (K) was applied at rates of 0, 30, 60, and 90 lb K/acre with liquid muriate of potash as the K source (1.3 lb K/gal). Both N and K rates were applied only to the corn area. In the following year, a uniform N rate, 90 lb N/acre, was applied to the cotton with no additional K. The factorial arrangement (7 x 4) of treatments was set up in randomized complete block design with eight replications across multiple soil types. All cultural practices and pesticide applications were maintained uniformly across both studies. Plots were harvested with commercial equipment adapted for plot harvest and samples collected for determination of harvest moisture, bushel test weight, and seed weight for corn and lint percentage on cotton. In 2008, the corn study area was divided into two studies to further evaluate N rates with different application (PP vs SD) ratios and also starter fertilizers for corn. Nitrogen rates were 140, 180, 220, and 260 lb N/acre applied in various ratios from 100% PP to 100% SD. No additional K was included in the study. Cotton followed corn in the subsequent years as previously described. This arrangement of treatments was continued through 2012 (cotton only in 2012)

In the original 2004 study, there was no significant interaction between N rates and K rates, so only the main effects were examined for both crops. In the initial year of the study (2004) corn yields ranged from 154 to 165 bu/acre with no significant yield increase obtained with N rates above 180 to 210 lb N/acre. Thus, the extra 90 to 120 lb N/acre was not utilized for additional grain yield. Yields in subsequent years were significantly higher and more in line with yields potentials for the area. In 2005, cotton yields following the previous corn crop ranged in yield from 864 to 903 lb lint/acre with no significant difference in yields as they related to the previous year=s N rates. Corn yields of 165 bu/acre removed about 150 lb N/acre from the field as harvested grain. Thus at the 300 lb N/acre application rate, 150 lb N/acre was not removed in the grain and should be left in the field as residue, organic matter, or as inorganic N remaining in the soil. Some of the cotton yield effects could have been masked due to losses from the hurricane-related wind and rain in 2005. Corn yields in 2005, harvested before the hurricanes, ranged from 197 to 207 bu/acre. While yields were

significantly higher than the previous year, there was still no large range in yields associated with N rates. Grain yields were not significantly increased with N rates above 180 lb N/acre. The 2006 cotton yields following corn (2005) ranged from 1,316 to 1,373 lb lint/acre with no significant difference in lint yield related to residual N levels. The 2006 corn yields ranged from 206 to 227 bu/acre with no significant yield response above 210 lb N/acre. In both 2005 and 2006, there was no cotton yield response to residual N from the previous corn crop. Rainfall totals and distribution were used in order to explain the potential for N loss from the systems. After the 2004 growing season, rainfall totals for October to the next April were 39.92 inches. Rainfall in 2004 was 68.00 inches (14.71 in above normal), with nearly 20 inches falling in May and June, after the initial N application. High rainfall and prolonged saturated conditions can lead to nitrification and denitrification and eventual loss of available N. In the Mid-South, rainfall distribution varies greatly from year to year and leads to quite varied results with respect to residual N. Cotton yields in 2007 were significantly influenced by residual N from the 2006 corn crop. September 2006 to April 2007 rainfall was lower than in previous seasons at 33.05 inches with little rainfall occurring after January and potentially higher residual N. Lint yields with 120 lb N/acre applied to corn were 1164 lb/acre compared to a high of 1258 lb lint/acre where 270 lb N/acre had been applied to the corn. While the differences are not great, they were significant and 2007 was the only year where differences occurred. In 2008, there was no response to residual N with lint yields ranging from 1351 to 1383 lb/acre. Excessive spring rainfall, along with warmer temperatures, should be indicators of the potential for N loss from the residual pool. After the first years, cotton response to residual N was only evident in one of the four years. In that year, rainfall was lower compared to other years. From this study, 90 lb N/acre was sufficient to optimize yields in three of four years. The normal recommendations would call for 110 to 120 lb N/acre for optimum production.

A new N management study was initiated in 2008 to examine the interaction of N rates and application ratios. The ratios varied from 100% preplant N to 100% sidedress N. Nitrogen rates were decreased overall and application ratios became of interest. Cotton yields in 2009 did reflect some indication of residual response with a significantly higher yield (1138 and 1145 lb/acre) at the higher N rates (220 and 260 lb N/acre, respectively) compared to the lowest N rate (1109 lb/acre at 180 lb N/acre), all of which were applied to the corn. The results were more pronounced in 2010 with cotton lint yields of 899, 940, 935, and 1000 lb/acre for the 140, 180, 220, and 260 lb N/acre applications to corn. This has been the greatest residual response to date. Lint yields in 2011 were not significantly influenced by N management on corn in 2010, even though 2010 corn yields were lower than other years. The 2011 corn yields were extremely low as a result of delays in irrigation. Even though the field received irrigation, it occurred after significant damage to the corn crop. Corn yields in 2011 were less than 100 bu/acre for most N rates and application systems. With these lower yields, one should expect more residual N remaining since the crop was unable to utilize the applied N. The 2012 cotton crop did show some increase due to residual N but only between th e140 and 180 lb N/acre rates. There was no further increase at the higher N rates applied to corn.

Based on cotton yields from the two studies study, there appeared to be little buildup of residual N from higher N applications on corn. Even in years where corn yields were lower, the N remaining in the soil profile following harvest was not readily available to the following cotton crop. In most years, temperatures and rainfall are sufficient to influence biological transformations in the soil and subsequent loss or tie-up of any available N. However, in the last few years cotton yields have been more influenced by the previous corn fertilization scheme. Rainfall totals in 2010, 2011, and 2012 were below normal. Monitoring rainfall totals and average temperatures can be used to assess the potential for residual N. Various tests have been evaluated over the years, but it is difficult to model a dynamic system that responds to climatic influences.