SITE-SPECIFIC NITROGEN MANAGEMENT FOR COTTON

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Abstract

Nitrogen (N) fertilizer is required for cotton fiber production, but the optimal N fertilization rate varies with soil and landscape characteristics within a field. In this study uniform rates of N fertilizer (0 to 150 lbs. N/acre in 30 lbs./acre increments) were applied side-by-side in field-length strips (15 ft wide by 1000 ft long). The optimal N fertilization rate was calculated for the six N rate (15 ft by 50 ft) harvested sub-blocks. For the field studied this created 36 individual N-response trials that were used to investigate spatial patterns in optimum N rate. For two site-years (1998 and 1999) we saw a 10X variation in lint yield–N. Statistical analyses showed that lint yield plateaued at the 90-100 lbs. N/acre increment. N treatment clearly affected yield, but soil conditions sometimes were more important in determining final yield. In this study effects of N treatments on cotton lint yield often were obscured by other yield-controlling factors.

Introduction

Cotton (*Gossypium hirsutm)* requires nitrogen (N) fertilization to achieve maximum yields. Proper N management is critical; lees than adequate N fertilization limits cotton lint yields while surplus N fertilization can cause rank growth. Excess N also may contribute to disease and insect pressure. Current University of Missouri soil test recommendations for N are based on cation exchange capacity (CEC). Nitrogen rates, in lbs. N/a, are calculated by the formula NR = (CEC X 3) + 50.

The cotton producing soils of Southeast Missouri are derived from deposits of the ancestral Mississippi and Ohio Rivers. They are extremely variable in CEC ranging in CEC values from 5.0 (loamy sand) to 28.0 (clay). An additional source of variability is the effects of the 1812 New Madrid Earthquake. This event caused liquefaction of subsurface sand layers that were then injected at the surface as sand boils. These features are typically 20 to 30 yards in diameter. The soil texture can change abruptly for sand to clay over a distance of 4 to 5 feet.

CEC is generally determined by soil testing. While this is accurate it is also time consuming and expensive. Given that changes in CEC occur over small distances other methods for determining CEC have been developed. One of these methods is in-situ electrical conductivity (EC). With this method an electric potential is applied to soils and the degree to which this current is transmitted to a receptor is recorded. Soil with low CEC generally has low EC while soils with higher CEC have greater electrical EC. Electrical conductivity readings may be combined with GPS coordinates to produce an EC distribution map. These maps may then be used in site specific N fertilization.

This study was conducted to evaluate the feasibility of site specific N applications based on soil textures as measured by EC. A second objective was to determine the most profitable N fertilization rates for each soil texture.

Materials and Methods

A Geonics EM38 instrument was used to map the electrical conductivity of soils in a non-irrigated 30-acre cotton field at the University of Missouri-Delta Center. The device is able to distinguish changes in soil texture because silt loam soils usually conduct electricity better than sandy soils. The following nitrogen rates were replicated four times in 1100 foot strips across a cotton field: 0, 30, 60, 90, 120, and 150 pounds N per acre. Before harvest, alleys were cut every 50 feet in the strips. We collected individual yields from every 50 feet area in each plot for a total of 528 yield observations. Latitude and longitude values were assigned to yields from each plot.

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Results and Discussion

Most of the cotton field contains silt loam soil with measured EC values ranging from 25 to 30 mSiemens per meter. Examining the data showed that there are two main groups of EC values. The largest group is the dominant silt loam soil and the small group is the sandy outcroppings. In silt loam soil areas, cotton yields increased with N rates up to 110 lb N per acre (Figure 1). Sandy areas were also found in the field with the Geonics EM38 instrument. Electrical conductivity readings and cotton yields were much lower in these areas than in the silt loam areas. In areas with EC values less than 15 mSiemens per acre meter the optimum N rate was 50 to 75 lb N per. Water was probably more limiting to yield than fertilizer in these areas. We are in the process of separating these groups and making regression models for each group.

Nitrogen response curves from 1999 and 2000 were used to calculate the most profitable amount of N to apply on cotton with current cotton and fertilizer prices. Cold weather has resulted in increased demand for natural gas in 2001. This has caused nitrogen fertilizer to be more expensive to produce. Table 1 shows the average yields for both years across all soils in the field. Each value is the average of 63 separate yield measurements at a given N rate in the field. Regression analysis was used to develop response curves for two-year yield averages (Figure 1). Table 2 shows the marginal revenue product (MRP) from each 10-pound N increment based on 60 cent per pound cotton. The marginal input costs (MIC) from each N increment in 2000 and 2001 was calculated based on N selling for 19 cent per pound in 2000 (10 lb increment X $0.19) and 32 cent per pound in 2001 (10 lb increment X $0.32). Applying additional N is profitable as long as the MRP is greater than the MIC.

Summary

With 2000 N prices, the most profit occurred with the 100 lb N per acre rate. Given 2001 N prices of $.32/lb, the MRP is less than the MIC at 100 lbs. N/acre. The decision rule would recommend applying 90 lbs. of N/acre with 2001 nitrogen prices. The marginal return for increasing the fertilizer rate from 90 to 100 lb N per acre was $3.05. But it cost $3.20 (MIC) to apply that extra 10 pounds of nitrogen as compared to only $1.90 in 2000. A change in the price of cotton or nitrogen would influence the most profitable N rate.

Table 1. Average cotton lint yield response to nitrogen fertilizer treatments in the test field 1999 and 2000.

Treatment	N Rate lbs. N/a	1999 yields	2000 yields
		----------lbs. lint/a----------	
1	0	559	623
2	30	671	739
3	60	658	754
4	90	780	720
5	120	771	744
6	150	791	713

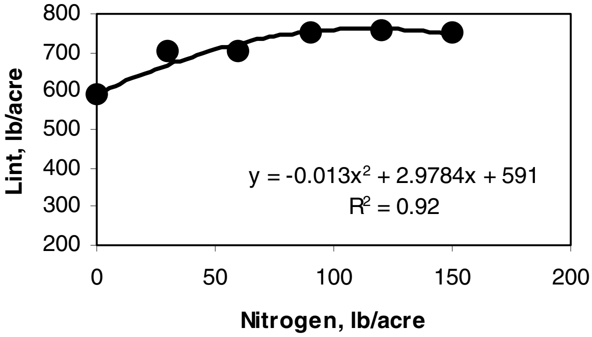

Figure 1. Cotton lint yield response to nitrogen averaged across 1999 and 2000.

Table 2.Econonic calculations using regression equation to predict yields from 60 to 120 lbs.N/a rates 2000 and 2001.

Nitrogen Rate	Predicted Lint Yield	Difference	Marginal Revenue	2000 Marginal	2001 Marginal
Lbs. N/a	-----lbs. lint/a-----		Product	Input cost	Input cost
60	723	------	------		
70	736	13	$7.80	$1.90	$3.20
80	746	10	$6.00	$1.90	$3.20
90	754	8	$4.80	$1.90	**$3.20**
100	759	5	$3.00	**$1.90**	$3.20
110	761	2	$1.20	$1.90	$3.20
120	761	0	$0.00	$1.90	$3.20

Marginal Revenue Product calculations are based on $0.60/lbs. cotton price. Marginal Input Costs are based on $0.19/ lbs.N in 2000 and $0.32/ lbs. N in 2001. Values in bold represent most profitable N rate.