ON-FARM NITROGEN RATE TRIALS CALIBRATE GROWER EXPECTATIONS

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Abstract

On-Farm nitrogen rate trials were established on two cotton farms in 2011 and repeated in 2012. The farms are located in the Mississippi alluvial plain and the Red River alluvial plain on non-irrigated fields. Three nitrogen rates were utilized – the grower standard rate, the standard rate plus 30 pounds N/acre and the standard rate less 30 pounds N/acre. Nitrogen was applied by knifing in a liquid 30-0-0-2S urea ammonium nitrate-based solution at sidedress approximately 30 days after planting. Each rate was replicated three times in the trial, and each plot was field length. Pre-application soil samples were extracted to ensure no other nutrient was a potentially limiting factor. Greenseeker NDVI data were collected at first bloom and 30 days after first bloom. Yields were recorded by yield monitor calibrated with a weigh-scale equipped boll buggy. The 2011 season was characterized by drought, with yield results indicating that nitrogen was likely not the limiting factor in crop growth. The 2012 season experienced more timely rainfall and results indicated that the grower standard nitrogen rate was significantly greater than the lower nitrogen rate, but that increasing the nitrogen rate above the grower standard did not result in increased lint yield. Yield differences were noted between in-field zones delineated by electrical conductivity.

Introduction

Steadily rising nitrogen input costs and increased concerns over potential effects of nutrient runoff are leading growers to examine fertilizer rates of application even more closely. Cotton producers will invest a substantial amount of money applying nitrogen (N) fertilizer in order to optimize yield. These growers depend on scientific research conducted by land grant universities in their state and their general growing region to determine the sufficient amount of N needed. Too little N applied will often result in less yield than the crop potential that existed for that year, and too much N applied may stimulate the plants to grow vegetatively at the expense of boll and lint production. Nitrogen rate studies are usually conducted at research stations on a periodic rather than ongoing basis. As new cultivars are introduced into the marketplace – purportedly with ever increasing yield potential – producers are understandably questioning if the latest cotton nitrogen rate research is up-to-date and applies in their situation. On-farm nitrogen rate trials were established in order to conduct a “spot check” of the efficacy of current grower nitrogen rates on non-irrigated cotton lint yields in Louisiana. Although the results are anecdotal in nature, as opposed to an extensive survey, the method employed in these trials could be adopted on a widespread basis, providing the producer data generated on his or her operation and allow them to make informed decisions on optimal nitrogen application rates.

Materials and Methods

On-Farm nitrogen rate trials were established on two cotton farms in 2011 and repeated in 2012. The farms are located in the Mississippi alluvial plain (Concordia Parish) and the Red River alluvial plain (Rapides Parish) on non-irrigated fields that have historically produced cotton lint yields in excess of 1100 pounds lint/acre. Three nitrogen rates were utilized and applied by the producer – the grower standard rate (GS), the standard rate plus 30 pounds N/acre (GS+30) and the standard rate less 30 pounds N/acre (GS-30). Nitrogen was applied by knifing in a liquid 30-0-0-2S urea ammonium nitrate-based solution at sidedress approximately 30 days after planting. Each rate was replicated three times in the trial, and each plot was field length. In 2012, the producer in Rapides Parish chose to drop the lowest nitrogen rate, and add two nitrogen rates higher than the grower standard, in addition to narrowing differences in nitrogen rates from 30 pounds per acre to 20 pounds per acre. The nitrogen rates in the field in Concordia Parish were further manipulated by zones delineated from soil electrical conductivity readings as a proxy for soil texture (Figure 1). Pre-application soil samples were extracted to ensure no other nutrient was a potentially limiting factor. Greenseeker normalized difference vegetative index (NDVI) data were collected post-nitrogen application at first bloom and 30 days after first bloom by scanning two rows per plot, approximately fifty feet in length per row. Tissue samples were collected from the second true leaf of 20 plants per plot on August 31st and analyzed for whole-leaf nitrogen content. Yields were recorded by yield monitor calibrated with a weigh-scale equipped boll buggy. Simple statistical procedures were applied to determine meaningful differences in yield between nitrogen rates (field-length yield means and standard deviations), and a simple cost/benefit analysis of input/yield was performed by observing the marginal rate of return on increased nitrogen applied above the lowest rate applied in the field.

Results and Discussion

Differences in yield between the 2011 and 2012 growing season were substantial across both locations (Table 1), primarily due to differences in soil moisture. The 2011 growing season was marked by prolonged drought, and water rather than nitrogen was likely the limiting factor in yield. The 2012 growing season began with sufficient soil moisture and periodic rainfall in both areas provided adequate moisture for sufficient crop production. In each year preplant soil samples indicated that pH, major and secondary nutrients were optimal enough to prevent potentially confounding results (data not shown).

NDVI ratings were collected post-fertilizer application to determine if this index was sufficiently sensitive to distinguish differences in crop vegetation based on nitrogen application rate. No meaningful differences were detected, as most values ranged between 0.75 and 0.85, regardless of location, year, and time after application. In contrast, late season leaf nitrogen content appeared to distinguish between nitrogen rates in 2012, but not 2011, with the lowest N rate in 2012 exhibiting less than sufficient leaf nitrogen content at approximately 3.5%. Higher N rates in 2012 – including the grower standard – resulted in leaf N content of greater than 4%.

There were no meaningful differences in lint yield in response to varying rates of nitrogen in 2011 at each location, but differences were observable based on field position – likely due to changes in soil texture and plant available water holding capacity. The 2012 growing season provided sufficient moisture for crop growth to allow for yield differences to occur based on the rate of nitrogen applied. Cost benefit analysis of 2012 yield data demonstrated that in both Rapides Parish and Concordia Parish, the grower standard provided the optimal rate of return over the lowest N rate applied (Table 2). In Concordia Parish, yields differed in 2012 based on soil electrical conductivity values that served as a proxy for soil texture. Soil samples were extracted by zone to determine actual soil texture class. Zone 1 was classified as a sandy loam, Zone 2 a silt loam, and Zone 3 a silty clay loam. Zones one through three yielded 1185, 1148 and 1055 pounds of lint per acre, respectively, exhibiting an incremental decrease in yield as soil clay content increased.

Summary

In relatively dry years on non-irrigated cotton in Louisiana, the most likely yield limiting factor is water rather than nitrogen. In 2012, when water was in sufficient supply through most of the growing season, the grower standard proved to be the optimal nitrogen rate, providing anecdotal evidence that cotton producers are applying appropriate rates of nitrogen to optimize yield without applying excess nitrogen. Increased nitrogen above the grower standard provided minimal or negative marginal rates of return on fertilizer. NDVI was not sensitive to differences in rates of applied nitrogen when data was collected post-fertilizer application. Precision agricultural techniques such as field mapping by electrical conductivity offer opportunities to fine-tune nitrogen application rates within a field in order to further optimize yields.

Table 1. Two-year nitrogen rates and lint yield responses of cotton fields located in the Red River Valley (Rapides) and Mississippi River Valley (Concordia), Louisiana.

Year	Location	N rate (lbs./acre)	Lint Yield (lbs./acre)
2011	Rapides	60	565
		90	564
		120	549
2012	Rapides	90	1032
		110	1060
		130	1067
		150	1040
2011	Concordia	90	758
		103	789
		120	770
2012	Concordia	90	1086
		110	1147
		130	1128

Table 2. Cost/benefit analysis of marginal rates of return above the lowest amount of nitrogen applied. For this analysis, fertilizer was assumed to cost $0.66 per pound of nitrogen; and lint yield value to the producer was assumed to be $0.70 per pound of lint.

N rate (lbs./acre)	Cost of N ($/acre)	Yield (lbs. lint/acre)	Gross return ($/acre)	Net return above lowest N rate ($/acre)
Rapides				
90	60	1032	722	------
110	74	1060	742	6
130	87	1067	747	-2
150	101	1040	728	-35
Concordia				
90	60	1086	760	------
110	74	1147	803	29
130	87	1128	790	3

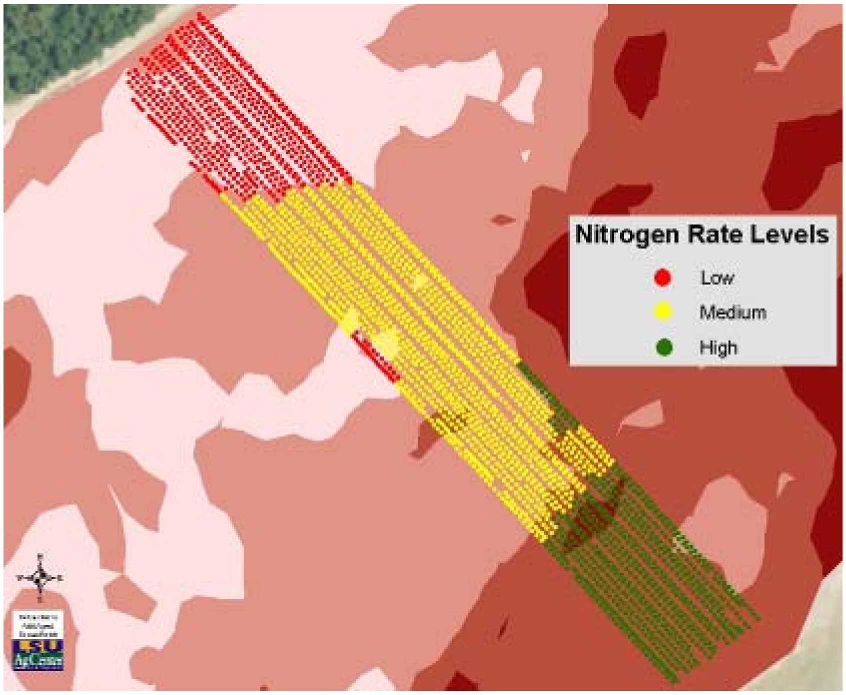

Figure 1. Cotton field in Concordia Parish delineated by variations in soil electrical conductivity as a proxy for soil texture. The field was divided into zones so that various levels of nitrogen could be applied based on soil texture. Additionally, high, medium, and low levels of nitrogen were applied within each zone.