MANAGING NITROGEN FERTILTY WITH ALTERNATIVE STRATEGIES IN THE MISSISSIPPI DELTA

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Abstract

Nitrogen (N) management continues to be a key topic of interest for most research programs in the Mid-south and one of the more costly inputs when examining the total cost of production for most crops. For cotton, N management has been quite complicated since cotton is a perennial. Perennial plants tend to adjust their growth and development to the environment and may or may not produce fruit and seed. With cotton, environmental stresses during reproductive growth could result in fruit shed and a shift back to vegetative growth. Once annual plants shift from vegetative growth to reproductive growth, they exert all energy to producing the next generation. Much of the recent research with respect to N has dealt fertilizer use efficiency. Efforts continue to get the most yield with the least input. Nitrogen applications can be quite varied, especially with respect to N applications. Application systems can spread applications from prior to planting through blooming and even beyond. The most desirable timing allows for maximum uptake with little loss to the environment or to other non-target species such as weeds. For phosphorus (P) and potassium (K), the application timing is not as critical as these nutrients are not as mobile. Fall applications are often the desired timing and allows the nutrients to stabilize in the soil solution. The objectives of stakeholders and site-specific soil, climate, crop, and management systems all have a significant impact on fertilizer management and should always be considered when selecting fertilizer Best Management Practices (BMP's). Getting nutrients to plants as close to the time they are needed leads to the most efficient use of nutrients whether coming from organic or inorganic sources. The plants themselves do not distinguish between nutrient sources. However, some crops such as rice preferentially take up certain forms while others through a symbiotic relationship with bacteria get N from the atmosphere. Many products are being brought to the market place with claims of increased nutrient use efficiency, reduced nutrient loss, nutrient stabilizers, or various other mechanisms to reduce nutrient loss or enhanced nutrient uptake. Not always are the mechanisms of activity evident from the literature provided by the marketer. In recent years products have been marketed to reduce ammonia volatilization, nitrification, denitrification or even some combinations that involve more than one mechanism. This research project was designed to evaluate some of these materials compared to traditional N sources, urea (U, 46% N) and urea-ammonium nitrate (UAN) solution (32% N) under dryland (rain-fed) and irrigated conditions and on different soil types.

Materials being evaluated in the current studies included ESN® (Agrium Advanced Technologies, Inc) Environmental Smart Nitrogen that is a urea granule within a micro-thin polymer coating. The coating allows water within the soil to move into the granule and dissolve the urea inside. The urea solution then moves out through the coating into the soil where it becomes available to the growing crop. A second material evaluated has been Agrotain® (N-(*n-Butyl*) thiophosphoric triamide (NBPT) from Koch Agronomic Services. This product has been billed as the world's leading urease inhibitor and is meant to reduce ammonia volatilization when coated on urea granules. Other companies have similar materials but generally the same active ingredient. The other product that was included in the study was NutriSphere-N® (Specialty Fertilizer Products, Leawood, KS). The enhancer is said to operate by "killing the spectrum of soil bacteria and manages N fertilizer at the molecular level." This product is also spray-coated onto granular urea or mixed with UAN solution to enhance nutrient uptake. In 2013, the NutriSphere-N treatments were replaced with an ESN+UAN or ESN+U with these system applied just after planting. Nitrogen rates of 90, 120, and 150 lb N/acre were used to establish a range of potential responses. All fertilizer sources prior to 2013 were applied as a split application, except ESN which was applied 100% at planting. For the split applications, 60 lb N/acre was applied just after emergence with the remaining N applied as a sidedress application (to establish rates) at the pin-head square growth stage (PHS). For the ESN+UAN and ESN+U systems, a uniform rate of either UAN or U (45 lb N/acre) was applied along with the remainder of each rate applied as ESN. All cultural practices were maintained uniformly through the season. The rain-fed (non-irrigated) study was located at the Tribbett Satellite Farm (TSF) on a Dundee-Forestdale silty clay loam with some Dowling soil intermingled. The experimental design was a factorial arrangement of treatment in a randomized complete block (RCB) design with five replications and grown as a continuous cotton system. The study was initiated in 2010 and continued

through 2013. The irrigated site was established in 2011 at the Delta Research and Extension Center (DREC) on a Dubbs silt loam. Since the irrigated study is rotated with corn, the study location varies from year to year and was located on a Newellton silty clay in 2012 and back to the Dubbs in 2013. Treatments were arranged in an RCB design with four replications. All granular treatments at each location were hand-applied pre-weighed samples applied after emergence. Each plot was harvested with a commercial spindle picker adapted for individual plot harvest. Grab-samples were taken at the time of harvest and ginned through a 10-saw micro-gin to determine the lint percent and subsequent lint yields. All data was then analyzed with the Statistical Analysis System (SAS Institute, Cary, NC) utilizing Analysis of Variance (ANOVA) with mean separation by Waller-Duncan K-ration t-test and Fisher's Protected Least Significant Difference. Previous research has shown a decrease in lint percentage as N rates increase so only lint yields will be discussed.

The first study at TSF was initiated in 2010 under rain-fed (non-irrigated) growing condition. Lint yields were not significantly increased with increasing N rates and had no significant effect due to the varying N source or combination of N source and enhancer. Lint yields ranged from 1170 to 1218 lb/acre across the different sources. In 2011, lint yields ranged from 592 to 643 lb/acre and again no significant difference. A new system, urea+Agrotain, was added in 2011 but showed no difference. As with the previous year, there was no N rate response. In 2012, lint yields were more than two times what they had been in 2011 and ranged from 1350 to 1398 lb lint/acre. Again there was no significant difference among the different sources when averaged across N rates.

In 2013, the U+NutriSphere-N (U+NS) and UAN+NutriSphere-N (UAN+NS) systems were replaced with ESN+UAN and ESN+U systems. For both systems, 45 lb N/acre was applied to each plot as either U or UAN and the remaining N (45, 75, and 105 lb N/acre) was applied as ESN. The UAN was "knifed-in" while the U and ESN were surface-applied as a broadcast. Cultivation was then used to help with incorporation of the dry materials. Cotton lint yields in 2013 were much higher than those measured in 2012. Lint yields ranged from 1400 to 1605 lb/acre. The lower yields were associated with the UAN+ESN system with no explanation why this system was significantly lower than all others. There was a significant response to N in 2013 with the greatest lint yield measured with 150 lb N/acre. In previous years, with lower lint yields there had been no response to increasing N rates indicating that sufficient N was available at the lowest N rates.

An irrigated study with the treatments previously describe was initiated in 2011 on the Delta Research and Extension Center. Lint yields under the irrigated conditions and sandy loam soil were twice those measured at TSF under rain-fed conditions the same year. The lint yields with ESN and U+Agrotain (averaged across N rates) were about 4% lower than the other systems but that difference was not significant. Yields at the150 lb N/acre were about 6% lower than the 120 lb N/acre rate, again not significant. The 2012 lint yields ranged from 1497 to 1568 with no significant difference between the N sources when averaged across the three N rates. The only system that tended lower was the ESN and was only 2.6 to 4.5% lower than the range of the other sources. In 2012, there was again no response to increasing N rates indicating that 90 lb N/acre was at least sufficient for the yields produced under rain-fed conditions.

The DREC yields in 2013 were much more variable than in any previous year of the study. Lint yields ranged from 1522 to 1737 lb/acre, yet were not significantly different at the 5% level as determined by the Analysis of Variance ($LSD_{(0.05)}$ = 167 lb lint/acre). The lower yields tended to be with ESN alone and with urea alone. The higher yields were with UAN and UAN+ESN. There was no significant N rate response on the sandy loam site (DREC) even with yields over 1600 lb lint/acre.

At both the rain-fed location (TSF) and the irrigated location (DREC), there has been little response to increasing N rates. For 2014, scientist plan to reduce the N rates in the study and include an unfertilized check. From the evidence obtained to date, there appears to be little difference between the nitrogen sources and the enhancers that have been evaluated. The NBPT products such as Agrotain and Arborite-Ag are both effective in reducing ammonia volatilization but are only effective if conditions promote the gaseous loss of ammonia. In many cases, when rainfall follows application, the ammonium is carried into the soil. This is true for any of the ammonium products. Some of the products such as NutriSphere-N has not been found to be effective in the field or in laboratory studies. Nitrification inhibitors are effective in reducing the conversion of ammonium to nitrite but may not lead to increased yields. The best mechanism to reduce N loss is to get the N in the soil as close as feasible to the time of maximum plant uptake.