EVALUATION OF NITROGEN MANAGEMENT IN COTTON PRODUCTION WITH AGROTAIN® NITROGEN STABILIZER

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Abstract

Nitrogen represents a substantial portion of input costs for cotton producers, and yet researchers report nitrogen fertilizer recovery efficiency (NRE) between 15–65%. Furthermore, agricultural practices that can directly affect NRE are changing, such as nitrogen source utilization (ammonium nitrate to urea) and tillage practices (conventional tillage to no tillage). NBPT is a urease inhibitor marketed as AGROTAIN® stabilizer, and is known to reduce ammonia volatilization from surface applied urea. Research studies conducted by land-grant University personnel have demonstrated its efficacy in rice production in the Mid-South, and as a result the adoption rate by rice producers is high. However, nitrogen management in cotton is far more complex. Data are presented from several Land Grant University field trials in cotton. Significant yield increases were observed in some, but not all, trials. Inspection of the data revealed that in one trial there was no significant yield response to nitrogen above the zero-nitrogen control treatment, and in two other trials there was sufficient rainfall soon after fertilizer application to incorporate the urea, negating the potential benefit of the urease inhibitor. However, in five other field trials, surface applied urea and/or UAN treated with a urease and/or nitrification inhibitor resulted in significantly greater lint yield or fertilizer recovery than untreated urea or UAN.

Introduction

Nitrogen represents a substantial portion of input costs for cotton producers, and yet researchers report nitrogen fertilizer recovery efficiency (NRE) between 15 – 65%. Furthermore, agricultural practices that can directly affect NRE are changing, such as nitrogen source utilization (ammonium nitrate to urea) and tillage practices (conventional tillage to no tillage). NBPT is a urease inhibitor marketed as AGROTAIN® stabilizer, and is known to reduce ammonia volatilization from surface applied urea. Dicyandiamide (DCD) is a known nitrification inhibitor that is marketed in combination with NBPT as AGROTAIN® PLUS stabilizer (for UAN) and SUPERU fertilizer™ (urea substitute). The combination of a urease inhibitor and nitrification inhibitor hold the potential to Research studies conducted by land-grant university personnel have demonstrated its efficacy in rice production in the Mid-South, and as a result the adoption rate by rice producers is high. However, nitrogen management in cotton is far more complex. Cotton is grown across a large geographic area in the southern half of the United States, representing a wide range of climatic conditions and agronomic practices. Native soil fertility utilized for cotton production varies greatly, from coarse-textured, low cation-exchange-capacity soils of the Atlantic Coastal Plain, to fine-textured, high cation-exchange capacity soils of the Mid-South and West. Irrigation practices also vary greatly, including dryland, flood, furrow, center-pivot and drip tape – all of which influence nitrogen management. Many cotton producers have switched sources of nitrogen, with a net reduction in ammonium nitrate and a net increase in urea-ammonium nitrate (UAN) and granular urea consumption. Moreover, the adoption of limited till and no till practices have increased over the past decade, increasing the potential for nitrogen loss through volatilization.

Materials and Methods

Two studies were conducted by Munk at the University of California's West Side Research and Extension Center in 2010 evaluating yield response to UAN with or without AGROTAIN® or AGROTAIN® PLUS stabilizers, one on Acala and one on Pima cotton. Nitrogen was applied at either 75 or 150 pounds of nitrogen per acre by surface broadcasting on June 29th. The first of two irrigations was applied on July 1st. The trial was planted on May 4th and harvested on November 4th and 9th.

In 2008, a study was conducted on upland cotton by Kawakami et al. at the University of Arkansas Cotton Branch Station in Marianna, Arkansas. The trial was planted on May 22 and harvested on October 15th. Preplant nitrogen was applied at the rate of 40 pounds of nitrogen per acre. Treatments of urea, urea plus AGROTAIN® stabilizer, SUPERU fertilizer™ were topdressed at the rate of 27 pounds of nitrogen per acre, except for the zero-nitrogen control plots, on a Captina silt loam.

The following year, Kawakami et al. conducted a study at the same station, but on a Loring silt loam. Cotton was planted on May 20th and harvested on November 14th. Nitrogen treatments were sidedressed, split applied (half at unfold cotyledon stage and half at pin-head square stage) as urea at 111 and 84 pounds of nitrogen per acre, urea treated with AGROTAIN® stabilizer at 84 pounds of nitrogen per acre, and SUPERU fertilizer™ at 84 pounds of nitrogen per acre.

In a large study in 2011 focused on tillage and nitrogen timing at the Judd Hill Foundation Research Farm in Poinsett County, Arkansas, Teague et al. applied urea on a Dundee silt loam with or without AGROTAIN® stabilizer at the rate of 100 pounds of nitrogen per acre at emergence, or split applied at emergence and first square, or split applied at emergence and first bloom. The tillage treatments were conventional, no-till, and winter wheat cover crop. Notably, a rain event of 0.66 inches occurred the following day. Moreover, irrigation was applied one day after the first square application and weekly through bloom.

In 2005 and 2006, Varco conducted a field study utilizing 15N enriched nitrogen fertilizer as urea and UAN, with and without AGROTAIN® stabilizer. Treatments were split-applied at the total rate of 120 pounds of nitrogen per acre, half at planting and half at early square, on a Marietta fine sandy loam soil at the Mississippi State Plant Science Research Center. A zero-nitrogen control treatment was included in the study. Upland cotton was planted on May 10, 2005 and May 8, 2006. UAN was wither banded (knifed-in), dribbled on the soil surface, or treated with AGROTAIN® stabilizer and dribbled on the soil surface. Granular nitrogen treatments included ammonium nitrate, urea, and urea treated with AGROTAIN® stabilizer, all of which were dissolved in deionized water and surface broadcast with a pump sprayer.

In 2007 Burmester conducted a study at the Auburn University Tennessee Valley Research and Extension Center, investigating irrigated cotton yield response to several nitrogen fertilizer products. The site had previously been in no-till wheat as a cover crop. The cotton was planted on April 24 following a preplant nitrogen application of 24 pounds of nitrogen per acre. Nitrogen fertilizer treatments were surface broadcast on June 5 (4-5 leaf stage) at the rate of 60 and 90 pounds of nitrogen per acre. Treatments included ammonium nitrate, urea, urea treated with AGROTAIN® stabilizer, and urea treated at two rates of calcium thiosulfate. A half inch of rain fell on June 12.

The following year at the same research station, Burmester conducted a similar study with several more treatments. Irrigated cotton was planted into a heavy rye cover crop residue on April 20, following a preplant nitrogen application of 30 pounds of nitrogen per acre. Treatments included ammonium nitrate, urea, and urea treated with AGROTAIN® stabilizer or calcium thiosulfate, as well as UAN and UAN treated with AGROTAIN® stabilizer or calcium chloride, and a liquid, slow-release nitrogen source. All treatments were surface broadcast on June 6. Notably, a light rain of 0.11 inches fell on June 9.

Beginning in 2008, Mitchell et al. conducted a 4-year, non-irrigated cotton trial at the Prattville Agricultural Research Unit in Central Alabama on a Lucedale sandy clay loam under no-till following a rye cover crop. Due to availability, treatments varied somewhat year to year, but always included urea and UAN with and without AGROTAIN® stabilizer. Nitrogen was applied at planting at the rate of 20 pounds of nitrogen per acre. Treatments were applied at the rate of 70 pounds of nitrogen per acre before first bloom.

Results and Discussion

In the study in on Pima and Acala cotton in California, at the optimal nitrogen rate of 75 pounds of nitrogen per acre, UAN treated with AGROTAIN® PLUS stabilizer resulted in significantly greater (P=0.05) Pima seedcotton yield than untreated UAN, an increase of 322 pounds of seedcotton per acre. Boll counts indicated that the increased yield was primarily due to an increase in third position bolls and late season boll development. The higher nitrogen rate of 150 pounds of nitrogen did not result in greater yield for any nitrogen source, indicating that at the higher nitrogen rate, nitrogen was not the limiting factor. On the other hand, seedcotton yields of Acala did not differ significantly(P=0.05) regardless of nitrogen source or rate, an indication that an enhanced efficiency nitrogen product was not able to achieve greater yields due to the fact that nitrogen at the rates applied was not a limiting factor.

The 2008 study by Kawakami et al. in Arkansas resulted in no significant lint yield increases (P=0.05) over the zero nitrogen control treatment. Indeed, the average yield for the zero nitrogen treatment was nearly 1,400 pounds of lint per acre. The highest yield recorded for a nitrogen fertilizer treatment was from SUPERU fertilizer™ at 1,800 pounds of lint per acre, which was significantly greater than the zero nitrogen control and urea treated with AGROTAIN® stabilizer, at P=0.10, but not greater than the urea treatment. On the other hand, the 2009 study by Kawakami et al. demonstrated that a reduced rate of nitrogen treated with AGROTAIN® stabilizer resulted in the same lint yield as the full rate of untreated urea (P=0.05), while a reduced rate of urea resulted in significantly reduced lint yield – an indication that protecting nitrogen from volatilization resulted in increased nitrogen use efficiency. Similar to the Pima cotton trial, the number of bolls was well correlated with relative yield, rather that greater boll weight.

The 2011 Arkansas study by Teague et al. investigating tillage and nitrogen timing did not result in significant differences in yield, regardless of timing or treatment with a urease inhibitor. Rainfall and irrigation events within twenty four hours of nitrogen application likely incorporated the urea to the extent that volatilization was not a concern, negating the potential benefit of the urease inhibitor. The average lint yield across all treatments was 1,229 pounds of lint per acre.

The Mississippi State study by Varco revealed that 15N enriched nitrogen fertilizer recovery was greater for liquid UAN solutions (38-47%) compared to surface broadcast granular fertilizers (20-36%). The addition of AGROTAIN® stabilizer to urea resulted in significantly greater 15N enriched fertilizer recovery (P=0.05) than untreated urea, and similarly, surface dribbled AGROTAIN® stabilizer-treated UAN resulted in significantly greater recovery than untreated UAN.

In the 2007 study by Burmester in the Tennessee Valley, urea treated with AGROTAIN® stabilizer produced a significantly greater (P=0.05) seedcotton yield than untreated urea by 326 pounds per acre. It is notable that this trial did not receive rain or irrigation for at least seven days after fertilizer application, resulting in a potential condition for substantial urea volatilization in the untreated urea. On the other hand, in the 2008 study, rainfall occurred within three days of the fertilizer application, reducing the potential for urea volatilization. Yield differences were greater from urea treated with AGROTAIN® stabilizer compared to untreated urea, but not significantly (P=0.05).

In the four year trial by Mitchell et al. yields were significantly greater for UAN treated with AGROTAIN® stabilizer than UAN in two of the four years, but urea treated with AGROTAIN® stabilizer did not result in yields that were significantly greater than untreated urea. The author noted that drought was a significant factor in the trial and that yields were disappointingly low throughout the study period, making conclusions on the influence of enhanced efficiency fertilizer difficult to assess.

Summary

In trials across the cotton belt, the addition of a urease inhibitor or a combination of urease and nitrification inhibitors resulted in increased lint yield or fertilizer recovery in cases where nitrogen was a limiting factor and nitrogen fertilizer loss potential existed. Trials in which nitrogen was not limiting or where volatilization was not a major concern (such as UAN knifed-in), usually did not result in a yield benefit from the use of a stabilizer. Cotton producers will need to assess their method of application and optimal nitrogen rates to determine if the marginal cost of adding a stabilizer will likely result in a reasonable return on investment. The data from these trials indicate that the potential exists for an agronomic and economic benefit to the producer by adopting stabilizer technology on their fertilizer when it is surface applied.

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