

**FERTILITY MANAGEMENT IN A CHANGING WORLD -  
SOURCES, COATINGS, INHIBITORS, AND ENHANCERS****Bobby R. Golden****M. Wayne Ebelhar****Mississippi State University  
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Nitrogen use efficiency in cotton (*Gossypium hirsutum* L.) has been reported to range from 30-59% in the Mid-South U.S. cotton growing region. With current input prices and environmental concerns, plant recovery of applied N must be efficient to reduce production costs and N losses to both groundwater and the environment. This presentation discussed potential nitrogen (N) loss pathways and entertain products that allow for strategies to minimize N loss with various modes of action. The most prevalent N loss pathways that may be partially reduced by current commercial N products are ammonia volatilization and nitrification/denitrification. All of which have a significant influence on N retention in the plant-soil system with regard to Mid-South cotton production.

Ammonia volatilization is a surface N loss mechanism. Ammonia volatilization occurs when urea or ammonium forming fertilizers are surface applied with minimal to no incorporation. Ammonia volatilization proceeds rapidly in warm, wet or humid conditions. This is primarily due to ammonia's, high affinity for water. Soil pH influences the potential for ammonia volatilization to occur. As pH increases chances for ammonia volatilization to increase go up. Soil buffering capacity also influences volatilization losses. On soils with low buffering capacities (silt loams) ammonia volatilization proceeds more rapidly and is greater in magnitude than on soils with a high buffering capacity (clays). Ammonia volatilization generally proceeds for about 10 d after fertilizer application. Urease inhibitor products are commercially available to help control or minimize ammonia volatilization; however the only active ingredient that has shown efficacy in reducing ammonia volatilization in the Mid-South is N-(n-butyl) thiophosphoric triamide (NBPT). To date products evaluated in Mississippi and found to have efficacy in reducing volatilization losses are Agrotain®, Arborite® Ag, Contain, Factor, NFIXX, NitroGain™ UI.

Denitrification losses can also be great in the Mid-South region due to our climate and production practices, especially where rainfall frequency and irrigation practices can create saturated soil conditions. Denitrification is a microbial mediated process that occurs shortly after a soil goes anaerobic. This process occurs when microbes use the nitrate present in the soil as an alternate energy source. As oxygen is depleted from the soil, facultative anaerobes consume nitrate as their electron acceptor. Moisture plays an important role in denitrification. As moisture increases, denitrification occurs more rapidly until all nitrates in the soil are consumed. Soil pH also influences denitrification. On high pH soils, denitrification proceeds more rapidly than on low pH soils. Nitrification is the process that converts ammonium to nitrate to be taken up by most plants. Rapid conversion of N to the nitrate form builds the pool N that is potential subject to denitrification. Proven active ingredients that show efficacy as nitrification inhibitors evaluated in the Mid-South are Dicyandiamide (DCD), and Nitrapyrin. Because denitrification is microbial in nature and soils differ in their inherent nitrification potential, many soils react differently to application of nitrification inhibitors, and product efficacy may be great or lessened depending on the soil itself.

A third mode of action that has efficacy against both ammonia volatilization and denitrification is products that use a physical coating to control the release of nutrients into the environment. The two most prevalent products available to agriculture for this category that have been evaluated in the Mid-South is sulfur- and polymer-coated urea. For these products the dissolution or release of N is controlled through physical processes. Water gains entry into the sulfur-coated urea (SCU) prill through microscopic pores and osmotic forces dominate the release of urea-N. The release profile of these products generally occurs in a three phase process which is controlled mostly by S coating thickness. The three phases are water intake, linear release, and eventually decay. The nutrient release of these products is primarily mediated by soil temperature. Research suggests that products with a controlled release of N must match the N demand curve of the crop to be viable. Currently, Environmentally Smart Nitrogen (ESN) is the only polymer-coated urea with any scale of adoption in row-crop cultivation. The release profile of ESN in the Mid-South suggests that product longevity is 35-40 d from application to full release. Sulfur-coated urea and ESN have shown promise for use in Mid-South cotton production systems.

One key in understanding and making enhanced N products viable at minimizing N loss is often overlooked. The producer or consultant must pick the correct mode of action to protect the investment made in N. A denitrification inhibitor will do little at reducing N loss if the N loss is occurring via volatilization, and vice-versa. Therefore it's not as simple as choosing a particular brand or trade name, the end user must fully understand the mechanism that is dictating how the N is being lost before measures can be taken and products selected to reduce the loss. The other key principle that one must understand is that these products often control the reactions in the soil but may not result in an economic gain or yield increase. Rainfall immediately following a urea application negates most urea volatilization as the urea is incorporated into the soil. The profit potential from many of these products may not lie in the yield gains as much as the impact on the environment.