NRCS	**Michigan Technical Note** **USDA-Natural Resources Conservation Service**

AGRONOMY #31
Subject: Description of Products That Enhance Nitrogen Use Efficiency
Date: September 2006

GENERAL INFORMATION

Conservation Security Program (CSP) Enhancement Sheet MI-CSP-04-3A was issued in October 2005. The following products are included as options for qualification of this payment. For CSP payment, the following is a description of the N Efficiency Products that qualify for payment:

Product List:

1. Nitrification and/or urease inhibitors (Ex: N-Serve, DCD, Agrotain, Super U, Super N)
2. Polymer- and sulfur-coated urea (Ex: ESN, Polyon, Trikote)
3. Urea reaction products (Ex: Nitroform, Nutralene, Nitamin)

Following are descriptions:

NITRIFICATION INHIBITORS

Nitrification inhibitors enhance N efficiency by slowing the conversion of NH4-N to NO3-N. By inhibiting bacteria that convert NH4-N to NO3-N, the ammonia N is held longer to the clay and organic matter in the soil and kept from leaching or denitrification. Most inhibitors can slow this process by a few weeks if added to anhydrous ammonia, urea ammonia nitrate (UAN or 28%) liquid nitrogen solutions, urea, or manure. N Serve (nitrapyrin) was originally a DOW Ag Department product that has been commercially available for 30 years. N Serve slows the conversion of ammonium nitrogen NH4-N to Nitrate Nitrogen in the soil. Dicyandiamide (DCD) is another compound that can slow nitrification but is not volatile as N Serve. N Serve is very effective on poorly drained or saturated soils that are water logged for several weeks in spring, as this is where denitrification commonly occurs. Any soils in MSU Soil Management Groups with b-somewhat poorly or c-poorly drained characteristics could benefit from nitrapyrin.

UREASE INHIBITORS

Urease Inhibitors can reduce nitrogen loss via volatilization due to urease enzymes present in soil and on surface crop residue. NBPT (N-[nbutyl] thiophosphoric triamide) sold under the trade name Agrotain reduces the activity of the urease enzyme found in crop residue for up to 14 days.

As long as it rains within that 14 day period (1/4 inch), urea is moved into the soil where it is converted to NH4-N without risk of volatilization. Nitrogen volatilization loss is most likely to occur when soil temperature is warming (greater than 60^0 F).

N volatilization is potentially higher under the following environmental conditions at the time of urea application: high pH (recently limed), dry soil moisture conditions, high surface residue cover, (broadcast spread urea on no-till corn after wheat residue, corn residue) or pasture conditions during warm wet weather followed by a breezy dry period. This is because when urea fertilizers are broadcast applied to a soil covered with residue there is more urease enzyme available to convert it to ammonia gas, hence more potential for ammonia volatilization, and the ammonia is directly exposed to the atmosphere.

CONTROLLED RELEASED NITROGEN

Controlled released nitrogen products were available 30 years ago. Sulfur coated urea is probably the best known product. A sulfur coating is applied to urea granules. The elemental sulfur coating oxidizes slowly by bacterial activity. The urea then dissolves/diffuses through imperfections in the coating. The thicker the sulfur coating, the slower N is released. However, it is fairly expensive to coat sulfur on urea. Therefore, it was never widely accepted or adopted in U.S. agriculture as a common fertilizer. Polymer-coated fertilizers were manufactured as early as the 1960s in Japan. A variety of polymers are used to form semi-permeable coatings on soluble N sources, usually urea. The N release mechanism is by diffusion through the coating rather than by disruption of the coating. Release is regulated by polymer chemistry, coating thickness, soil moisture, and soil temperature. Recent advancements have decreased production costs to an economical level for commodity grain crops. Examples: ESN, Polyon.

"New plastic technology has created the polymer coated urea (PCU). These products are used in the turf and horticulture industry for years, but their high cost excluded their wide spread use on Midwest farms. AGRIUM has patented newer plastic technology (PCU) called ESN that is competitively priced in the agricultural market. Modern polymers allow chemists to create release curves that closely match the uptake characteristics of target crops. The amount of the release is controlled by the thickness and other characteristics of the polymer."

UREA-REACTION PRODUCTS

Most synthetic organic N fertilizers, constituting a large portion of the CRN fertilizers available in the U.S., are known as urea-aldehyde reaction products such as urea formaldehyde and methylene urea. Urea formaldehyde, first patented in 1924 in Germany, was first commercially produced in 1955. Commercial fertilizers are mixtures of urea and 'urea-form' polymers of varying molecular weight and typically contain about 30-35% N. These slowly soluble organic compounds release N in the soil by chemical and/or biological decomposition processes. Solubility and N release are varied by altering the molecular weight and cross-linking of the urea polymers. Primary soil factors governing N release are moisture, temperature, and pH. Today, some liquid products are available by making soluble 'urea-form' polymers. These products have been limited to horticultural application because of high cost. Examples: Nitroform, Nutralene, Nitamin.

Georgia Pacific has released NITAMIN, a mixture of urea-reaction compounds that breakdown with soil microbial activity and release N by their patented STEADY-DELIVERY ™ system. NITAMIN delivers nitrogen to crops at a rate that they can effectively utilize throughout the growing cycle. NITAMIN binds to the soil, even in heavy rain, reducing loss through leaching.

UREASE INHIBITOR AND NITRIFICATION INHIBITORS

SuperU (marketed by Agrotain International) is urea with both NBPT and a nitrification inhibitor (dicyandiamide DCD). SuperU was designed to prevent losses associated with surface application of urea as well as leaching and denitrification losses. Super N is a liquid concentrate containing the same inhibitor combination for use with UAN.

Further research and field trial studies are on-going to refine the rate and timing of these various products to maximize their use with minimizing the loss of Nitrogen to the environment. The goal is to competitively price these products and maintain crop yield and profitability to the grower.

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