UNIVERSITY OF VERMONT EXTENSION

CULTIVATING HEALTHY COMMUNITIES

Are Fertilizer Additives Like NutriSphere-N and Avail Worth the Money?

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Nitrogen fertilizer is expensive. Whether we realize it or not, spreading nitrogen on corn fields is real drama. Imagine loading up your spreader with 50-cent pieces, spreading them on your field, and hoping that you will be able to find them when September rolls around. That is basically what we are doing when we spread nitrogen-containing fertilizer, regardless of whether it is in manure or from a synthetic fertilzier. Nobody wants to spend more than will pay them back at the end of the year. Farmers are well familiar with the ways that nitrogen can be lost from their fields, and want to take steps prevent that from happening.

In recent years, there have been several products that have emerged on the market, with claims that they can help reduce fertilizer nitrogen loss, and therefore help to improve yield or reduce input costs. This past January, Dr. Tom Morris (Univeristy of Connecticut) delivered an excellent presentation on the subject, and I am going to summarize it here, with additions and modifications. To understand what the products claim to be able to do, it is essential to understand the forms of nitrogen present in the soil and their various vulnerabilities.

Nitrogen is present in soils in three basic forms

- ***Organic forms*** of nitrogen from decaying plant material, manure, soil organisms, etc. This form is not easily lost until it breaks down into mineral forms.
- ***Ammonium*** (NH_4^+) is released from organic matter as it breaks down, but it also is a component of many fertilizers. Being positively charged, it binds to the soil (which has a negative charge) and is not easily lost until it is converted by microbes into nitrate.
- ***Nitrate*** (NO_3^-) is a negatively charged moleucle and therefore does not bind with soil particles (which are also negatively charged). It tends to move with water as it moves through the soil, so it can be lost by leaching and can end up in groundwater and surface water. In soils that are warm and water-saturated, oxygen-starved bacteria have ways of taking the oxygen from the nitrate (NO_3^-), which leaves only dinitrogen (N_2), which is a gas; plants cannot use this form of nitrogen, and it is lost to the atmosphere. This process is called 'denitrification.'

Related to this subject of nitrogen loss is a process called 'volatilization.' For our purposes, to call this 'evaporation' is close enough. When the urea hits the soil, it reacts with a common soil enzyme called urease, causing the formation of ammonia (NH_3) Once this happens, the ammonia will do one of two things: enter the soil solution, interact with water, and become ammonium (which will bind to the soil); or it is free to evaporate, which will happen at a rate dependent on temperature, humidity, wind speed, etc. Ammonia is extremely volatile, and it tends to be lost unless it enters the soil, reacts with water, and is converted into ammonium.

Now, if someone could invent a product that would keep ammonium from converting to nitrate too quickly or that would reduce/prevent denitrification, we ought to be interested….if the price is right, of course. The products listed, in some circumstances, seem to be able to do what they claim.

So, how much leaching and denitrification do you have each year on your farm?

Before we can determine whether these products will be cost-effective for your individual fields it is important to know the most common way nitrogen is lost from your soils. Nobody can tell you exactly how much nitrogen you lose each year due to leaching or denitrification, but if you understand how nitrogen is lost, you probably have a better sense than most. If you have sandy soils that are well-drained or even excessively drained, leaching is probably a primary way you lose nitrogen. If you have fine-textured soils that tend to be saturated for extended periods of time even when the soil warms up above 60º F, denitrification is a real threat. If you have soils that are 'shallow to bedrock' and you tend to get a lot of rain and/or have flowing water nearby, I will hypothesize that leaching is a major concern for you in those locations. Finally, if you tend to topdress urea and/or manure without incorporation, you probably lose significant amounts of nitrogen to volatilization.

Now, let's move on to talking about what these products claim to do. First, what are the products that we are talking about?

Urease inhibitors (such as Agrotain®): Think of enzymes such as urease as complex molecular machnines designed to to a particular job. In this case, urease is made to break down urea, which is common in the environment, into its component parts so it can re-enter the nitrogen cycle. That is a good and noble function if there ever was one, but we want it to happen after the urea that we spread is further down in the soil so that when the urea is broken down and ammonia is formed, it will not evaporate. If many of the urease molecules present in the soil in and around the fertilizer particles are incapacitated, that would allow more time for rain to come to move the urea into the soil before it is converted into ammonia and potentially lost. One of the active parts of the urease molecule contains an atom or two of nickel, which are necessary for this enzyme to effectively break urea down. It is believed that urease inhibitors such as Agrotain® bind the nickel part of the molecule and/or many of the nickel ions in the soil, rendering the urease ineffective, at least for a while. This gives time for the urea to move into the soil with rain or incorporation before it is converted into ammonia, which can easily be lost.

Nitrification inhibitors such as N-Serve® and Instinct® are intended to slow the process of nitrification, which is the conversion of ammonium to nitrate by soil microbes. Remember: ammonium is not easily lost, but nitrate *is* easily lost via leaching or denitrification (in warm water-saturated soils). In this case, copper (rather than nickel) is involved in the process and these nitrification inhibitors are believed to bind the copper, slowing or stopping the nitrification process for some period of time.

In addition to pure urease inhibitors or nitrification inhibitors, there are also combination products:

- Agrotain Plus: nitrification inhibitor + urease inhibitor
- SuperU: urea + Agrotain Plus
- Nutrisphere-N: nitrification inhibitor + urease inhibitor

Finally, there are products such as **ESN** ("environmentally smart N") that are coated with either polymers or sulfur, which acts as a physical barrier around the fertilizer particle that causes urea to be released more gradually than it normally is.

How Effective Are These Products?

I have no doubt that these products work to varying degrees in the laboratory and in the field. What is less clear from the data summaries that I have seen is whether they work well enough in common field settings to justify the added expense. It is also worth asking whether one would be better off trying to reduce nitrogen costs and losses byquickly incorporating the fertilizer, improving the time of application, etc. The duration and degree of their effectiveness of these products will be determined by many factors including:

- Soil temperature
- Soil characteristics, including organic matter, biological activity, microbial populations
- Precipitation and soil moisture
- An interaction of the above

To state the obvious, these products can be expected to work if your conditions are generally favorable for the kinds of loss that the products are supposed to prevent. If your soils are not terribly prone to leaching and your soils do not often become water-saturated for long periods of time when the soil is warm, the nitrification inhibitor will have less value for you. If you tend to incorporate your urea so that volatilization is not a concern, or you apply it soon before rain and/or during cool weather, the urease inhibitors will have less value for your farm. If you plan topdress without incorporation, and seasonal precipitation patterns suggest that it is likely that it will not rain for several days, the urease inhibitors will have more value.

This is not a simple subject, but there is a lot of data available, which I would be glad to share. If you would like to have more of a conversation about whether any of these products might be right for you, do not hesitate to contact me at the St. Johnsbury Extension Office or email me at daniel.hudson@uvm.edu .

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