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Plant Nutrition TODAY
Better Crops, Better Environment...through Science

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Winter 2008-09, No. 1

CROP NUTRIENT ECONOMICS: PRICE RATIOS

"Agriculture is beset by uncertainty, especially as regards weather and prices." (C.A. Black, 1993)

Fertilizer prices shot up in early 2008. Crop prices surged and retreated, and with uncertainty in global financial markets it's hard to predict where they are going. So what does it mean for the way you manage crop nutrients?

The concept of price ratio has been an integral part of the theory of fertilizing for optimum profit since fertilizer marketing began. As fertilizer prices increase relative to those for crops, optimum rates decline, and vice versa when crop prices increase—so the theory goes. Based on the law of diminishing returns, the influence of price ratios can be illustrated quite nicely with figures showing crop response curves. A host of mathematical techniques have been devised to do the calculations.

However, there are several problems with the theory of price ratios. Key pieces of information needed to apply the theory may be missing. The price the producer will receive for the crop may be unknown. A long time may transpire between the fertilizer purchase and its payback from the sale of the crop. And the exact nature of the crop response function to the nutrient in question may be unknown.

First, how well can you know the price of a crop at decision time for fertilizer? Futures markets allow a price to be locked in. But it isn't wise to sell the whole expected crop on the futures market, since weather may drive production below expectations. Assuming that an April futures price for December delivery will hold until harvest is dangerous—and frequently leads to overestimating crop prices.

Second, how long will it take to sell the crop? For producers with storage, the optimum time of sale is rarely at harvest, and may vary from late winter to just before the next crop comes off. This could mean as much as two years between the fertilizer decision and the payback. Some producers may even prefer to look at price ratios a different way: compare the price received for last year's crop to the price of fertilizer for this year's. While as a practical rule of thumb it may control overspending by avoiding dangerous assumptions on prices, it doesn't fit the theory for applying the law of diminishing returns to the fertilizer investment. It's the price of the crop that responds that counts.

Third, let's deal with crop responsiveness. How well can a producer know how much the crop will respond, and how much to apply to get that response? Decades of research have led to many ways to estimate this response function, which are built into sound agronomic recommendations. The precision of the estimate depends on getting as much information as possible to predict soil nutrient supply and fertilizer use efficiency, set a realistic yield goal, and balance nutrient inputs and removals. When all this information is available, even the best recommendation systems are only capable of addressing half of the variability around the average true optimum rate for a crop.

The take-home message is that every tool in the box needs to be used to ensure that amount applied is as close as possible to the amount the crop needs. Take advantage of every information source that fits into your local recommendation system. This may include soil testing, analysis of local trends to predict attainable yield, plant analysis of previous crops, remote sensing, chlorophyll sensing, past response trials, previous crop history, and rates and analysis of manures applied.

The theory of price ratios, despite its weaknesses, is still valid. It rarely calls, however, for large changes in application rates. When prices increase, first ensure the agronomy behind your management of plant nutrients is sound. Are you using every tool available to choose the right product, to predict the right rate, to apply it at the right time, and to place it where it's most effective? Price ratio theory can help fine-tune rates, but only after the fundamentals of sound agronomic recommendations have been applied.

—TWB—

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WHAT DEPTH SHOULD SOIL BE SAMPLED?

The most common soil sampling depth taken is usually the topsoil or the cultivated layer. This is done for a number of reasons. First, the majority of soil biological activity occurs within the topsoil, or at least the cultivated layer of the soil being farmed. Secondly, this is the easiest layer to sample – considering time, effort, and type of soil sampling equipment required. The depth sampled varies, but is usually the top 6 to 12 in. (0.15 to 0.3 m) of the soil. Lastly, this sampling depth gives a reasonable estimate of the availability of most plant nutrients.

Deeper and multiple layer sampling is used to better estimate residual nutrients under specific crop, soil, and climatic conditions. Deeper sampling depths are usually collected separately by a few depths. For example, when sampling down to 24 in., it can be done in two or three separate samples, specifically 0 to12 and 12 to 24, or 0 to 6, 6 to 12 and 12 to 24 in. This is done primarily to determine the availability of nutrients that are more mobile in the soil, especially N, but can also include S. Specific forms of these soil-mobile nutrients move readily downward with soil water. This is especially important on coarse textured or sandy soils that are irrigated or normally receive ample precipitation.

It can be most important to know the extent of residual N as it can greatly affect crop growth and quality. For example, a shallow soil sample (e.g. 6 in.) may contain low levels of plant-available N, but considerable residual N may be lower in the soil within rooting depth of the crop grown. In crops where excess N can adversely affect crop quality, a shallow soil test may lead to a fertilizer recommendation supplying more N than required for crop yield and quality parameters. An example of a crop adversely affected by excess N is sugar beet, where excess N results in more protein and less sugar in the roots thus resulting in less extractable sugar. Another important reason is to avoid leaching of NO_3-N into groundwater, which can adversely affect drinking water quality from shallow wells used as water sources for livestock and humans. Lastly, residual N can be used by the crop, allowing a farmer to apply less N fertilizer and reduce input costs for the crop being grown.

Knowing the field history can be very useful when deciding how deep to take soil samples. One example I remember was a field near Calgary, Alberta, planted to forage oats to be used for livestock hay. The landowner had recently purchased the field during the winter. Soil sampling was done a few weeks before planting, in early May, to a 6 in. depth. Plant-available N was estimated as deficient, i.e. approximately 10 lb N/A (12 kg/ha), as indicated in the soil test results. An average 4 ton/A oat green-feed hay crop for the area removes about 130 lb N/A, so an additional 120 lb N/A was applied as 240 lb/A of urea (46-0-0) fertilizer before final seedbed tillage and planting. Later in the summer, the oat hay from the field was sampled and submitted to a feed testing laboratory for feed quality analysis. The test results showed that there was an excess level of NO_3-N in the hay and recommended it not be fed to cattle unless mixed sufficiently with low NO_3-containing hay. It was determined that the field had previously been in alfalfa that was plowed down 2 years before the oat crop and fallowed the year previous to planting. Above normal precipitation during the fallow year had leached residual N down below 12 in. This residual N was not accounted for in the 6-in. soil depth sample, but the oat crop roots effectively removed N down to about 36 in. If the person formulating the fertilizer recommendation had known that the field had been plowed down from alfalfa and fallowed for a year, a deeper soil sampling to at least 24 in. could have been done and much of the residual N from decomposing alfalfa roots and stems would have been detected.

There are conditions when deeper sampling can dramatically increase your ability to make an improved fertilizer recommendation. It is useful to check with your local soil test laboratory, a certified crop adviser, or state or provincial extension staff to determine if deeper and multi-layer soil sampling will better help you assess plant available nutrients for specific crop, soil and moisture conditions.

—TLJ—

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Abbreviations in this article: N = nitrogen; NO_3^- = nitrate; S = sulfur.

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CAN MANURE HELP THE BOTTOM LINE IN CROP PRODUCTION?

As the cost of fertilizer rises, farmers are increasingly looking at alternatives to provide nutrients for high-yielding crops. Many farmers are seeking manure from nearby animal producers to supplement their nutrient plans. Before jumping to the conclusion that manures are the best option for you, consider a few factors before making that decision.

To determine a value for manure nutrients, the manure expenses should be compared with the cost of fertilizer nutrients that would have otherwise been purchased. Also consider the expenses of obtaining the manure and additional hauling or application costs.

When a farmer buys commercial fertilizers, only those nutrients that might limit crop yield are purchased from the dealer. Manure contains many nutrients which may not be needed in the soil to boost plant growth. When considering fertilizer with manure, only the nutrients that are actually substituting for commercial fertilizer have economic value. For example, if supplemental zinc is not needed, do not credit economic value to the zinc that is present in the manure when making the comparison.

The amount of each plant nutrient in manure is controlled by the animal diet and the storage system. Manure rarely contains nutrients in the ratio that would be recommended for crops. For example, when manure is applied to meet the N requirement of corn, it is common that that 4 to 8 times more P is added than will be taken up by the crop. When manure nutrients are applied in excess to what may be desirable, they should not be counted as "fertilizer replacement" in the economic analysis.

A portion of the nutrients in manure is released in subsequent years as microbes slowly break down the organic compounds. The long-term value of manure can be hard to predict and is not always positive (such as N mineralization when no crop is growing can lead to nitrate leaching). It is not recommended to overload the soil with manure in one year with expectations of a high residual value in subsequent years.

It is essential to get an accurate laboratory analysis of the manure to determine its true value. Charts and books are useful as a general guide for manure composition, but cannot replace actual measurements. If it is not possible to get an analysis prior to spreading, take a sample from the tank or spreader on the day of application to send to the laboratory.

Consider the nutrient requirement of the crop, the nutrient content of the manure, any yield boost supplied by the manure, the application rate required, and the cost of application. After gathering this information, the true value of the manure can be determined and compared with commercial fertilizer.

From an economic point of view, the decision to utilize manure can be determined by considering several factors:

- The value of the nutrients that would otherwise be purchased (and fertilizer application costs);
- The savings of second-year nutrients following the initial application;
- Any indirect impacts of added manure (such as compaction, added organic matter, changes in tillage and weed control);
- Manure hauling and transportation costs.

Animal manure can provide an excellent source of nutrients for crops. However, do not immediately assume that manure is a better choice than commercial fertilizer. Do a careful analysis and use the most appropriate nutrient source for your situation.

—RLM—

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A FERTILITY ASSESSMENT CHECKLIST FOR WINTER

Times are turbulent and crop production risks are ever higher. How does your crop nutrition program fare in this environment? Here are some things to check during the winter months.

Past Performance. Look at trends in yield levels over time. The longer you can go back the better. Trends reflect growing conditions as well as management decisions. Experts have shown that genetics and fertility are dependent on one another. Proper nutrition does two important things: 1) provides its own degree of stress tolerance, and 2) makes it possible for the plant's genetics to fully express themselves, which may include additional stress tolerance.

Context. The fertility program that is adopted on a piece of ground can be compared to other fertility programs. University Extension recommendations are publicly available on university websites and have a scientific basis. They are intended to be used as guideposts, recognizing that local conditions require tailored management. Particular items to check are soil test levels, nutrient rates, and recommended sampling.

Nutrient budgets. For immobile nutrients such as P and K, compare how much of each nutrient has been applied to how much has been removed through crop harvest. Look backward. A good reference point is the date of the last application. From that date, sum nutrient removal for each crop grown since then. If removal exceeds application rate, soil test levels are expected to decline. In contrast, if removal is less than application rate, soil tests levels are expected to increase. For information on nutrient removal rates, consult university Extension publications or visit >www.ipni.net/northcentral/nutrientremoval<.

Soil fertility records. For immobile nutrients, soil test levels are a primary factor in making fertilization decisions. Be sure records are current. If your information is dated or non-existent, soil testing provides a tremendous return on the investment. Results provide the information needed to make an informed decision. Without them, money can easily be wasted.

Planning. Put a plan in place to monitor the next crop's fertility status. There are a variety of tools already available and ready for use that are typically underutilized: tissue testing, visual deficiency symptoms, chlorophyll meters, and stalk nitrate testing to name a few.

This winter, time spent evaluating current fertility practices can lead to improved approaches that help us calmly react to these turbulent times and reduce the risks we can manage.

—TSM—

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Abbreviations in this article: P = phosphorus; K = potassium.

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A SOIL NITROGEN TEST FOR RICE PRODUCTION

The long-term sustainability of Midsouth rice production depends on efficient management of N fertilizer. Nitrogen fertilizer recommendations for rice in the Midsouth are typically based on grain yield potential of a particular variety or hybrid. However, research has demonstrated that optimum N rates could vary as much as five-fold for comparable varieties grown on similar soil types due largely to site-specific variability in soil N mineralization. The development of a simple soil test for available N can improve the efficiency of rice production.

Various testing methods such as inorganic soil N, biological incubation, and hydrolyzable N [the Illinois Soil N Test (ISNT)] have been evaluated for several crops, but none have been calibrated for use in rice. Some work with incubation tests has shown some promise for rice; however, the test is untimely and the results were highly variable. A better understanding of N availability and how it affects Midsouth rice yield is needed. The development and adoption of a soil N test for rice will help ensure continued improvements in profitability and environmental sustainability of Midsouth rice production.

The rice research team at the University of Arkansas has completed 28 site-years of studies evaluating soil N testing methods for rice. They conducted replicated N response trials on several silt loam soils at experiment stations and in farmer fields across Arkansas. They evaluated the relationship between grain yield and soil N measured using either the ISNT or direct steam distillation (DSD). Good correlation was found between both the ISNT and DSD with relative grain yield across locations.

Results were best using a soil sample collected from an 18 in. depth. The ability of the ISNT and DSD to predict relative grain yield improved with each 6-in. increment down to 18 in., then decreased using a 24-in. sample. This result conflicts with traditional thought that a 6-in. sample is appropriate for assessing available soil N. Relative grain yield in rice appears to be highly dependent on soil N mineralization potential as well as subsoil N availability.

Calibration of a soil-based N test is the most critical step in determining its potential to affect production. The researchers in Arkansas found a strong relationship between soil test N using the two methods and N fertilizer need for their study sites. Similar to their results with grain yield, the best relationship existed at the 18 in. depth. Comparing N rate recommendations based on soil analysis with the standard recommendation for Arkansas rice production, they found deviations in optimum N rate ranging from zero (the standard recommendation was accurate) to 150 lb N/A (the field was non-responsive to N fertilizer), with the average deviation being 81 lb N/A.

These results indicate the strong need for a soil-based N test for fertilizer recommendations in Midsouth rice production; however, more research is necessary. The work in Arkansas was only conducted on silt loam soils with low variability in total N and C and inorganic N. Additional research has been established in Louisiana, Mississippi, and Texas to evaluate soil N testing methods on other soil textures and in different yielding environments.

Site-specific N management is a goal for producers of many crops and identifying the "right rate" for Midsouth rice growers may become easier in the near future.

—SBP—

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Abbreviations for this article: N = nitrogen; C= carbon.

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NOTCHING UP YOUR NITROGEN KNOWLEDGE FOR THE NEW YEAR

The portion of the applied fertilizer N taken up by most cereal crops in the growing season in which it is applied may range from 40 to 50%, across the USA. In the very best, intensively managed scenarios, crops may take up 60 to 75% of the applied N. Does that mean the remainder of the applied N is lost to the environment? The quick answer is no, but it depends on how the fertilizer N was managed, the soil chemical, physical, and microbiological properties, and the environmental conditions. Some of the applied N that is not directly recovered by the crop in the season N was applied, may be found as ammonium in the soil on cation exchange sites, trapped in the lattice of clay minerals, and in the soil organic matter pool.

Crop recovery of applied N can be enhanced in many fields by first recognizing the possible pathways for N loss. These loss pathways include: surface runoff, leaching below the root zone, ammonia volatilization, denitrification, and immobilization. Reducing the risks of N loss to these different pathways, especially when the crop's root system is not fully developed and the plants are not rapidly absorbing N, can enhance N use efficiency and effectiveness. Often, the greater the ratio of precipitation to evapotranspiration, and the warmer the soil and air temperatures, the greater the risks of loss via runoff, leaching, and/or denitrification.

As professionals who are committed to wise N management, we strongly encourage using science-based fertilizer BMPs (best management practices) or the four R's: right source, rate, timing, and placement. Choosing the right N sources for the specific circumstances, and managing them properly for each crop, with a knowledge of the prevailing soil and climatic conditions, will go a long way toward enhancing crop uptake and fertilizer N recovery.

Enhancing your knowledge and N management abilities will help make sure that every unit of N you apply is working to produce good crop yields and quality. Folks in the upper Midwest are painfully aware of the damage associated with excessive rainfall and waterlogging experienced in many fields in the spring of 2008. If one believes the climate change predictions, weather variability and uncertainty may become more the norm in the future than in the past.

There are many more tools and management options available to farmers and crop advisers today than in the previous decades. Costs associated with wrong decisions add up more quickly than in the past. If you have not completed your N management plans for the 2009 cropping year, approach your crop adviser, fertilizer dealer, or extension agent for science-based information and professional advice. Expand your knowledge, plan to make N management choices based not just on the price per unit of N, but also on how well you can manage the N source. There may be more ways than you realized to alter your management or to hedge your risks, to optimize crop recovery while minimizing the risks of N losses from your fields in 2009.

—CSS—

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Abbreviations for this article: N = nitrogen.

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CONSIDER THE SOURCE

Crop production in today's world is changing at an incredible rate. Crop and input prices have both shifted in ways that even a few years ago would have been unimaginable. For example, according to government statistics (National Ag Statistics Service of USDA) the average price of anhydrous ammonia in the spring of 2003 was $0.23/lb N. By the spring of 2008, 5 years later, it had doubled to $0.46/lb N. Similarly, the September prices received for corn from 2003 to 2008 went from $2.13 to $5.17/bu, and for winter wheat over the same period it went from $3.25 to $6.63/bu. Moreover, the costs for P and K fertilizer increased at staggering rates over a period of a few months.

Many have observed that the optimal rates of N have really not changed much over the past few years since the ratio of fertilizer to crop prices remains near the same. It still takes N to produce yield for non-leguminous crops, and yield, up to a point, is what produces profit. Likewise, P and K are no less important in crop nutrition than they ever were, even though prices are higher. A recent issue of *Better Crops with Plant Food* magazine (available online at **http://www.ipni.net/**) had several articles addressing these issues. The thing that has changed is the initial outlay and amount of risk involved.

Among the considerations for best nutrient management decisions is fertilizer source or type. There are many source considerations to take into account in sound nutrient management planning. For example, when it comes to N fertilization and placement, most of us are familiar with the idea of loss potential for N applied inappropriately. Coverage of this extensive topic is beyond the scope of this brief piece; however, there is a wealth of information available from many sources on this topic.

Another and separate consideration for source or type concerns claims about non-traditional products that one sees from time to time. Some manufacturers claim that their sources (N-P-K) can be used at greatly reduced rates without yield reductions. While there have been many technological advances in the fertilizer world that have the potential to improve fertilizer efficiency, none have yet to trump fundamental agronomic principles.

So, the point of all this is to always evaluate unusual claims for fertilizer sources under the lens of sound crop nutrition principles. Use caution in accepting hard-to-believe claims, but at the same time don't discount the many significant advances that have been made that have the potential to legitimately improve fertilizer management options. Examples of these include coated fertilizer technologies, and nitrification and urease inhibitors. Check with local certified crop advisers or extension professionals for more information, as an extensive coverage of legitimate enhanced efficiency technology is not possible in this brief format.

It is as important as ever these days that advisers and growers make sure that best management practices (BMPs) are used in nutrient management programs. The principles of BMPs account for the use of the right fertilizer source, with the right placement, at the right rate and right time. Remember, there are no magic bullets when it comes to sound nutrient management. And if a product's claims sound too good to be true, they very likely are.

—WMS—

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Abbreviations in this article: N = nitrogen; P = phosphorus; K = potassium.