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

From Scientific Staff of the
International Plant Nutrition Institute (IPNI)
3500 Parkway Lane, Suite 550
Norcross, Georgia 30092-2806 USA

Phone: 770-447-0335 Fax: 770-448-0439
E-mail: info@ipni.net Website: www.ipni.net

Winter 2009-2010, No. 1

HOW TO CHOOSE AN ENHANCED-EFFICIENCY FERTILIZER

Fertilizers form part of the environmental footprint of farming. A footprint is the sum of all resources used and impacted in producing something. If producers can enhance the efficiency of fertilizers, they can shrink the footprint of farming while boosting profits.

Many products to enhance fertilizer efficiency have become available. Slow-release forms and inhibitors have been around for decades, and the advent of nanotechnology promises to put an even wider array of products into the market. How does a producer choose the right one? Here are six key questions you can ask to help make the right decision.

1. Do you know the mode of action, and is it relevant to your crop, soil, and climate? Any product designed to enhance efficiency acts on the processes that can limit the availability of a nutrient from a particular fertilizer source, under particular circumstances. You can be confident in a product that has a relevant mode of action published in the scientific literature. If it doesn't, it's an experimental material in which you wouldn't want to invest a lot until you've done a few years of well-replicated on-farm testing.

2. How has the product performed in fields like yours? Field testing is necessary even if the mode of action is well-defined, because not all modes of action address issues that truly limit efficiency. Ask to see the field testing data. Not just a few examples, because efficacy varies from one field to another, depending on soil, crop, and weather. You need crop response data from a range of sites and a range of years. Also ask whether the data are from all situations tested, or selected for particular circumstances or types of situations.

3. How does the product perform in your fields? Your specific conditions—soil, crop rotation, tillage management, etc.—influence the efficiency of uptake of plant nutrients and the efficacy of specific products designed to enhance that efficiency. That's why field testing on your own farm is important. Split fields are ineffective tests – two halves of any one field rarely yield the same. Replicated strips are necessary to sort out random noise from true effects. Crop advisers can help ensure the right decisions are drawn from your data.

4. Does the product enhance your ability to plant at the optimum time? Determining how the product fits in with the rest of your field operations is important. Look closely at the rate, timing, and placement recommendations specific to the enhanced-efficiency product.

5. Do you have opportunity to improve? Measure your efficiency, and compare to industry norms. For example, in recent years, North American corn producers have been getting about 1.2 bushels of grain per pound of N fertilizer applied, on average. Since this average includes fields with manures applied and preceding perennial legumes, not every field can attain this level. But how do yours compare? If you know the nutrient analysis of the crops you are harvesting, you can also calculate a nutrient balance as another decision aid. If you already remove as much nutrient as you apply, it's hard to improve efficiency.

6. What opportunities exist for innovation? Innovative use may offer new opportunities to boost crop yields. For example, a recent study in Nebraska showed that controlled-release urea could boost the N uptake of soybean without slowing its biological N fixation, raising the yield ceiling in intensive irrigated production.

Enhancing efficiency has many benefits. Getting answers to the six questions above will guide your expectations for the opportunity to shrink your environmental footprint with enhanced-efficiency products. If you can cut losses of ammonia and nitrate, reduce greenhouse gas emissions, improve yields, boost quality, and save trips across the field, you can truly reduce your environmental footprint—and increase your profits sustainably.

– TWB –

For more information, contact Dr. Tom Bruulsema, Northeast Director, IPNI, 18 Maplewood Drive, Guelph, Ontario N1G 1L8, Canada. Phone: (519) 821-5519. E-mail: Tom.Bruulsema@ipni.net.

Abbreviations: N = nitrogen.

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Winter 2009-2010, No. 2

COMMERCIAL AND MUNICIPAL BY-PRODUCTS: ARE THESE USEFUL SOURCES OF NUTRIENTS?

"One man's trash, is another man's treasure" can have application when it comes to nutrient management. The use of materials considered as waste by a manufacturing plant, city, or farm, can be considered a resource by someone else. For millennia there has been common practice of disposing of waste products by spreading these materials on farm land. Often, this can be beneficial to growing crops. For example, when manure from a livestock facility is spread and incorporated onto nearby fields of neighboring farms, the plant nutrients in the manure are utilized by subsequent crops.

Application of municipal and industrial waste by-products onto agricultural land is also a common handling method. Often, these products contain plant nutrients and utilizing them as sources of nutrients is beneficial to both the city or factory and crop production on the farmland. However, industrial wastes often contain elements or compounds that are not required or beneficial to crops and in some cases can increase residually in soils to the point of crop toxicity, or be taken up into the harvested portions of crops to the point that the feed or food becomes unsuitable for livestock or human consumption. For example bio-solids from some municipal sewage treatment plants do contain plant nutrients from human waste, but also can contain heavy metals from cleaning and construction compounds that limit how much and how often municipal bio-solids can be applied to land.

When landowners are approached by a company wanting to apply an industrial by-product onto their land, there are a few matters to consider. First, does the product contain plant nutrients and is the mix and amount of nutrients manageable as part of the farm's nutrient management plan? Second, are the levels of unneeded and/or potentially toxic elements or compounds low enough to allow land application without adverse crop or environmental consequences? This can be especially important if multiple applications of the products are planned over a number of years. Third, will the landowner be compensated for inconveniences or economic costs due to when the products are applied on fields?

If a company wants to apply a waste product containing plant nutrients at no cost or even compensate the landowner financially, the owner needs to know all the subsequent effects before agreeing to receive the waste product. In some cases, there may not be much benefit to the farmer, either as a source of plant nutrients, or as a source of payment for disposal. But if the product will have no adverse effects on crop production, or long-term soil health, they may agree to receive the product. One example common in the Northern Great Plains region is the land application of oil-field drilling fluids. These drilling fluids are produced when oil and gas wells are drilled. They are made up of water and added compounds needed to lubricate the drill bits of oil rigs, mixed with ground-up rock material from the surface down to the oil or gas containing geologic formations. When an oil well is drilled in an area, the adjacent land owners can be contacted to see whether they are willing to allow land application of drilling fluids. This land application can be much less expensive than if the drilling fluids are hauled to a landfill for disposal, and environmentally the landowner can help reduce material entering local municipal landfills.

Land application of waste products can be a so-called "treasure" to a farmer if it contains plant nutrients needed to grow crops, or if the financial compensation for allowing application helps the economic stability of the farm operation. However, it is important that the farmer be aware of all the elements and compounds and their concentrations contained in the waste material and whether or not it will be beneficial, or at least not adverse, to crop production and land environmental health in both the short-term and long-term. It is useful for a landowner to have advice from an agronomic and environmentally knowledgeable consultant or crop adviser before agreeing to receive waste products onto their fields.

– TLJ –

For more information, contact Dr. Thomas L. Jensen, Northern Great Plains Director, IPNI, 102-411 Downey Road, Saskatoon, SK S7N 4L8. Phone: (306) 652-3535. E-mail: tjensen@ipni.net.

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Winter 2009-2010, No. 3

DO YOUR NUTRIENTS BALANCE?

Now that the 2009 crop has been harvested, it's time to take a look forward and prepare for an even better season next year. Many decisions will have to be made before the growing season begins again, including an assessment of the specific nutrient requirement of each field that will be needed to support high yields again next year.

You may hear plenty of talk about nutrient planning and budgeting. This may include developing a comprehensive nutrient management plan that accounts for all of the nutrients brought onto the farm with fertilizer, animal feed or manure, and other off-farm resources. Nutrients primarily leave the farm in harvested crops and animals. Other inputs and outputs, such as N fixation, erosion, and leaching also need to be considered.

Soil analysis can help monitor the nutritional status of your fields. If fertilizer application rates are calculated to only replace the harvested nutrients, you may not be adding the correct amount of fertilizer. If the soil nutrient concentrations are in the low or medium range, merely adding sufficient fertilizer to replace the quantity of nutrients removed in the harvested crop may result in depressed yields. If soil analysis reveals nutrient concentrations in the high and very high range, it may be possible to trim your application rate.

Use all the available tools for your nutrient planning. In addition to soil testing, use estimates of nutrient removal, yield goal projections, and an assessment of available nutrient resources. Soil testing is the cornerstone to all other nutrient management decisions. When used consistently, soil testing is especially valuable to monitor trends and to guide decisions for long-term profitability and productivity. If the soil nutrient concentration is declining over time, it may be necessary to boost the application rate. If the nutrient concentration remains in the sufficient range, then perhaps only a small starter application will suffice this year.

Farming practices with a nutrient deficit are successful only where you already have a large nutrient reserve in the soil. Many nutrient plans call for maintenance applications, where annual additions of replacement nutrients are recommended. However, this decision should only be made after knowing the facts. Ignorance of your soil conditions is not the way to make the best decisions.

Consult with your crop adviser for help in gathering all the data and to draw on the best field-tested recommendations for your area. Remember that many tools exist to make nutrient management planning a science-based activity for all your fields. Dividends of profitability and environmental stewardship come from keeping your nutrients in balance.

– RM –

For more information, contact Dr. Robert Mikkelsen, Western North America Director, IPNI, 4125 Sattui Court, Merced, CA 95348. Phone: (209) 725-0382. E-mail: rmikkelsen@ipni.net.

Abbreviations: N = nitrogen.

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NEW 4R ARTICLE APPEARS IN *CROPS & SOILS* MAGAZINE

During 2009, *Crops & Soils* magazine, published by the American Society of Agronomy and available free to all holders of CCA, CPAg, CPSS, and CPSC certifications, ran a series of articles covering the basics of 4R Nutrient Stewardship. The 4R Nutrient Stewardship concept defines the right source, rate, time, and place for fertilizer application as those producing the economic, social, and environmental outcomes desired by all stakeholders in the plant ecosystem.

The final article in the series, appearing in the November-December issue, is entitled "Know Your Fertilizer Rights: Right Place." Previous articles in 2009 introduced the 4R Nutrient Stewardship concept (Mar.-Apr. issue), followed by discussions of right source (May-Jun.), rate (Jul.-Aug.), and time (Sep.-Oct.). With the current article, a total of 15 authors have contributed to these publications.

In the article on the "right place", authored by Dr. T. Scott Murrell (IPNI), Dr. Guy Lafond (Indian Head Research Farm, SK), and Dr. Tony Vyn (Purdue Univ., IN), the topics discussed are: nutrient uptake by roots, managing fertilized soil volume, and managing limited root access to nutrient supplies. General principles are provided, along with illustrative examples taken from corn, soybean, and wheat crops. The article is accompanied by a self-study continuing education unit (CEU).

***Crops & Soils* magazine is available on request to current CCA, CPAg, CPSS and CPSC members at >https://www.agronomy.org/publications/crops-and-soils<.** Reprints of the individual articles are available to all readers, regardless of certification, at >**http://www.ipni.net/4r**<. This link also provides access to supplementary materials and background information on 4R Nutrient Stewardship.

– TSM –

For more information, contact Dr. T. Scott Murrell, Northcentral Director, IPNI, 2422 Edison Dr., West Lafayette, IN 47906. Phone: (765) 463-1012. E-mail: smurrell@ipni.net.

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THE RIGHT WAY TO GROW WHEAT…4R NUTRIENT STEWARDSHIP

Wheat is a staple in almost all human diets. In the coming decades, fertilizer will play a key role in producing the additional wheat needed to feed our rapidly growing population. 4R nutrient stewardship can help achieve the economic, environmental, and social goals of the sustainable agricultural systems needed to meet the global demand for wheat.

4R nutrient stewardship is focused on four central components: applying the right fertilizer source at the right rate, at the right time in the growing season, and in the right place. Each of the four "rights" is directly related to the other three in at least one way, interconnected into a unified, effective system. While some wheat production systems will have unique fertility needs, the scientific principles behind the specific recommendations are the same. These principles form the foundation of 4R nutrient stewardship.

The best fertilizer source for wheat will vary among sites and regions. Whatever fertilizer sources are determined to be the most appropriate, the nutrients must be in forms that the plant can take up. Both liquid and dry fertilizers supply nutrients in water-soluble, plant-available forms. However, caution should be used when making in-season applications of liquid fertilizer as foliar damage can occur. Early in the season there is virtually no risk of grain-yield-loss due to leaf-burn. However, later in the season, the risk increases.

The key to optimizing fertilizer rate in wheat is to match nutrient supply with crop requirement. Soil testing is a valuable tool for determining nutrient needs before the season begins. Once the crop is up, tissue analysis can help guide in-season nutrient applications.

Similar to fertilizer source, the timing of nutrient applications varies among wheat production systems. Many of the soils in the Southeast are prone to leaching, so very little, if any, N is applied in the fall to winter wheat. However, in some of the states in the western part of the region and throughout much of the Great Plains, fall N applications are more common due to lower leaching potential and the desire for more fall forage production for grazing.

The variety of fertilizer sources available to be used in wheat results in several placement options. For example, anhydrous ammonia must be injected below the surface of the soil, dry sources are broadcast or banded depending on the production system, and liquid sources, such as UAN, are often applied directly over the top of the growing crop.

Following 4R nutrient stewardship can improve fertilizer effectiveness and efficiency for a wide range of wheat production practices. To learn more about how the 4Rs can be applied to wheat production, visit the IPNI website at **www.ipni.net** in early 2010 to view the video "The Right Way to Grow Wheat…4R Nutrient Stewardship". If you want to simply know more about 4R nutrient stewardship, look for the video titled "The Right Way to Grow…4R Nutrient Stewardship". It will be available on the website in early 2010.

–SBP–

For more information, contact Dr. Steve Phillips, Southeast Director, IPNI, 3118 Rocky Meadows Rd., Owens Cross Roads, AL 35763, Phone (757) 999-2839. E-mail: sphillips@ipni.net.

Abbreviations: N = nitrogen; UAN = urea ammonium nitrate.

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PRECISION TECHNOLOGY FOR RIGHT NUTRIENT MANAGEMENT

Managing nutrients right – right source, right rate, right place, and right time – may be best accomplished with the right tools. Various technologies are available to aid farmers and their advisers in decisions related to nutrient management, from soil sampling to fertilizer application to yield measurement. These technology tools can enhance their ability to fine-tune nutrient management decisions and develop the right site-specific nutrient management plan for each field. The farmer and the farmer's employees, management and agronomic advisers, and input suppliers all are part of a team, each contributing to the decision process in different ways.

Right management means site-specific management. Making decisions on source, rate, timing, and placement with information collected on the specific field is the best way to be assured those decisions will produce the most efficient, most economical, and most environmentally appropriate nutrient management plan. Costs of being wrong are much greater under today's prices for inputs and today's crop prices. That means the price paid for technology to fine-tune those decisions is easier to justify.

The price for the technology need not be great. Costs have gone down for many of the tools as more people have adopted them. Many of the components of site-specific management do not require a lot of investment. Better records are a major step for many farmers. Just using better accounting of inputs and yields for each field is an important starting point. Employing GPS to geo-reference input and yield data may be the next step. Most fertilizer and chemical dealers now have GPS-guided application equipment. Most harvesting equipment now comes with GPS as a standard…or easily added…feature. The same system can usually be transferred to planting equipment for collecting geo-referenced the planting data, starter fertilizer application, and other inputs. With addition of proper controllers, variable-rate application of inputs can be added to the management plan. Each of these steps can be added over time, so that the initial investment can be built upon. In recent years GPS guidance has been the hot-seller, helping avoid costly skips and overlaps, saving on input costs for seed, fertilizer, and pesticides. Most farmers say reduced operator stress and fatigue are a major added benefit.

Again, records are a key element. With GPS guidance and tracking technologies, and on-board sensors, monitors, and controllers, huge amounts of data are available for the farmer and advisers to use in further refining the management system. To best utilize the information collected on the farm, a GIS record system is important. That 3-letter term need not scare anyone. It is a powerful tool for managing large amounts of geo-referenced data… the kind of data generated by modern agriculture's tools and practices. There is a need for decision-support services for farmers, consultants, and input suppliers…support services that focus on data management and analysis for these management team members. Implementing a system of GIS-based records that enables all members of the team to have access to the details for each field.

Early efforts to assemble such a comprehensive, shared data management system have had limited success, but there is a resurgence of interest. The software and communication systems have improved. Excellent outside sources of data, such as digitized soil surveys and weather information, are now available to complement the farmer's data for use in decision-support tools. Most important, more farmers are collecting data, leading toward the "critical mass" of customers needed to sustain a support service offering, either as an independent operation or as an add-on service from an input supplier. Most have learned that properly managing and interpreting those data require outside help, and that they can glean much more benefit by sharing the data with their adviser partners. Various programs are being implemented by seed, fertilizer, and chemical companies, or by technology data service providers. These programs will help address the growing information management needs of 21st century farmers who are seriously attempting to put the right nutrient source on at the right rate at the right time in the right place.

– HFR –

For more information, contact Dr. Harold F. Reetz, Jr., Director of External Support and FAR/IPNI, 107 S. State Street, Suite 300, Monticello, IL 61856-1968. Phone: 217-762-2074. E-mail: hreetz@ipni.net.

Abbreviations: GPS = Global Positioning System; GIS = Geographic Information Systems.

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STEPPING UP TO THE PLATE

Agriculture is increasingly looked upon as a major contributor to environmental nutrient-related problems faced by our society.

- Water quality issues such as eutrophication in the Chesapeake Bay and hypoxia in the Gulf of Mexico have garnered regional to international attention.
- The U.S. Geological Survey, EPA, and state authorities have identified trends in increased groundwater nitrate-N contamination in some parts of the country.
- Most of us are becoming more familiar with global climate change threats and air quality challenges posed by elevated greenhouse gas emissions. Although agriculture contributes less than 7% of the total U.S. greenhouse gas emissions, agriculture is the dominant source of nitrous oxide emissions. (Nitrous oxide is a potent greenhouse gas with a global warming effect about 300 times that of carbon dioxide.) Agricultural soil management, which includes fertilizer and manure N applications, accounts for more than two-thirds (2/3) of the country's nitrous oxide emissions.
- Emissions of ammonia from livestock operations and from some urea-containing or ammonium-containing fertilizer applications are of concern because ammonia in the air is considered a factor in the formation of fine particulates ($PM_{2.5}$) that form smog, which threatens human health.
- Loss of biodiversity of plants and some animals has also been blamed on excessive loss of nutrients in the environment.

These environmental challenges have frequently been placed at agriculture's feet, and sometimes they have been thrown in our faces. Poorly understood by our urban cousins, the unfortunate truth is that all agricultural systems...because they are biological, dynamic, and dependent on soils...will "leak" some amount of nutrients, no matter what we do. For example, even in the very best crop management systems on our most productive soils, loss of N from the soil may exceed 7 to 10 lb/A/year in drainage water alone. Research has shown that uptake and recovery of applied N by most crops in the season of application is often less than 50%. This implies the remainder is held in the soil, or has been lost to the environment via several different loss pathways.

Whether we agree with all the blame "bestowed" on agriculture, we must recognize that any excessive loss of N and P from farm fields represents an economic loss to farmers and their communities, and an erosion of valuable natural resources. If not addressed, this could adversely affect long-term soil productivity and sustainability. With fertilizer and cropping system best management practices, and an understanding of the risks and pathways for nutrient loss, farmers and their advisers are in a position to improve crop nutrient recovery, increase yields, and reduce nutrient loss. As winter sets in, and spring cropping management plans are developed, determine what you will do differently in 2010 to improve your crop yield response and nutrient recovery efficiency. There are many opportunities and tools available to improve crop production efficiency and effectiveness, but most must be employed in a site-specific manner. When agronomic performance is optimized, benefits to the environment usually also result. Will you be "stepping up to the plate" with an eye on changes that can be made in 2010 through improved nutrient management decisions and actions?

– CSS –

For more information, contact Dr. Clifford S. Snyder, Nitrogen Program Director, IPNI, P.O. Drawer 2440, Conway, AR 72033-2440. Phone 501-336-8110. Fax 501-329-2318. E-mail: csnyder@ipni.net.

Abbreviations: N = nitrogen; P = phosphorus.

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PHOSPHORUS FERTILIZER SOURCES

Questions are often asked about the effectiveness, composition, and plant availability of various P fertilizer sources. Questions such as "Is liquid more available to the crop than dry P fertilizer? Is one source better than another in alkaline soils? Can the optimum P rate be reduced with certain sources?" are not uncommon. These and other questions can be addressed in a simple review of the fundamentals of P fertilizer sources.

Practically all inorganic P fertilizers come from phosphate rock (PR) which is a naturally occurring sedimentary rock composed largely of calcium phosphate minerals (apatite). Most conventional commercial P fertilizers are made by reacting PR with sulfuric acid to produce phosphoric acid (green or wet process acid). The phosphoric acid is further reacted with ammonia (ammoniation) to produce ammonium phosphate fertilizers such as diammonium phosphate (DAP) and monoammonium phosphate (MAP). Production of ammonium polyphosphate fertilizer (APP) requires dehydration and polymerization of phosphoric acid prior to ammoniation.

The most common commercially available inorganic P fertilizers are DAP, MAP, and APP. These sources have the advantage of high water solubility (≥ 90%) and high plant food content. DAP and MAP are both ammonium orthophosphates. Orthophosphate is the form of P that is absorbed by plant roots, so after these granular materials have dissolved, their P is available for crop uptake. Although both of these sources perform similarly on a "per unit P" basis, there are differences worth noting. An important difference is in the potential for ammonia production when placing P in the seed furrow. In-furrow DAP has somewhat greater potential for seedling ammonia damage than does MAP, especially in alkaline and/or calcareous soils. Therefore, in-furrow recommendations for MAP are generally more lenient than for DAP. Another difference between the two sources is the pH of the initial soil reaction…with DAP it is about 8.5, whereas with MAP it is 3.5. There have been some reports of improved crop response with MAP compared to DAP on calcareous and high pH soils, but most agronomists agree that there is generally little difference in the performance of these two sources.

The term polyphosphate refers to two or more orthophosphate ions combined together. This polymerization is accomplished by the dehydration of phosphoric acid. Liquid APP fertilizers are produced by ammoniation of polyphosphates. Before plants can utilize polyphosphate it must be converted to orthophosphate via a hydrolysis reaction. This conversion occurs rapidly enough in soils that it does not affect the value of APP as a P source. One unique and advantageous characteristic of APP is its chelating or sequestering ability. Relatively high concentrations of micronutrients can be maintained in APP solution through sequestration.

When selecting a P fertilizer source here are important points to keep in mind:

- Evaluations have shown that fertilizers containing at least 60% water soluble P are effective in meeting crop requirements during the growing season;
- Common P fertilizer sources perform similarly when equal rates are applied and method of application is comparable;
- Except where P fertilizer is to be placed with seed, the source that is the best will usually be determined by factors such as product availability, preference, dealer service, and price.

– WMS –

For more information, contact Dr. W.M. (Mike) Stewart, Southern and Central Great Plains Director, IPNI, 2423 Rogers Key, San Antonio, TX 78258. Phone: (210) 764-1588. E-mail: mstewart@ipni.net.

Abbreviations: P = phosphorus.