Focus: Nitrogen Management

Feature
Nitrogen management: nitrogen credits, nitrogen tests and SPAD meters, and nitrogen placement

Continuing Education
Earn a CEU: Know your fertilizer rights

Technology
Enhanced efficiency fertilizers and stabilized nitrogen technology

Industry News
Monsanto closer to providing first drought-tolerant corn product

Company Strategies
Improving the uniformity of anhydrous ammonia application
Missing out on 75–95% of your fertilizer’s efficiency

Just isn’t efficient.

Every season, as much as 75–95% of the phosphorus fertilizer you apply to your soil never makes it to your crops’ roots. Instead, it is tied up in the soil by elements like calcium, iron, aluminum and magnesium.

AVAiL® Phosphorus Fertilizer Enhancer creates a shield around the fertilizer to block these elements so your crops’ roots can have access to more of the phosphorus they need. In fact, university studies and independent field trials show that acres where AVAIL was added to phosphorus fertilizer applications yielded 10–15% above acres treated with fertilizer alone. Visit our Web site to see the results for yourself.

Wasted fertilizer is wasted money. Talk to your dealer about increasing your phosphorus fertilizer efficiency – and your yield potential – by adding AVAIL.

chooseavail.com  888-446-GROW
The focus of this issue is on nitrogen management. See pages 4–11, 32–34, and 36–38.

4 Feature
Nitrogen management: nitrogen credits, nitrogen tests and SPAD meters, and nitrogen placement. Plus, fulfilling the needs of the agronomic professional.

13 Continuing Education
Earn a CEU in Nutrient Management by completing the first self-study course in a five-part series titled “Know Your Fertilizer Rights.” Also, earn a CEU in Soil and Water Management.

25 Career Center
Check out the latest job opportunities.

26 Certification
Continuing education for today. Plus, Newly Certified, Meet the Professional, and NAPT Working for You.

30 New Products
Featuring a fertilizer additive, irrigation efficiency device, precision ag display system, and a silage bagger.

32 Technology
Enhanced efficiency fertilizers and stabilized nitrogen technology.

34 Industry News
Monsanto closer to providing first drought-tolerant corn product.

36 Company Strategies
Understanding ammonia: Improving the uniformity of anhydrous ammonia application.
Making sense of nitrogen credits for corn production

By Larry G. Bundy, professor emeritus, Department of Soil Science, University of Wisconsin, Madison, WI

Increasing nitrogen (N) fertilizer costs make an accurate assessment of corn N needs more important than ever. Accurate determination of N fertilizer needs in corn production requires information about the amount of N necessary to optimize yield and estimates of how various factors influence the amounts of N available from nonfertilizer sources. Potentially important nonfertilizer N sources include legume forages and cover crops in rotations, manures, soybean in rotations, and soil N contributions. Crediting or accounting for N from these sources is essential for profitable corn production.

The key initial step in crediting N from nonfertilizer sources is to obtain a reliable estimate of the corn N requirement appropriate for the production situation. Usually this involves reference to N rate guidelines or recommendations for corn provided by university extension or other sources. Recently, there has been a shift from the use of yield-based recommendations to those based on corn N response data and economic considerations. An interesting history of N recommendation approaches used in Indiana has been compiled by Dr. Jim Camberato (2008).

Several Corn Belt states have adopted a similar approach to corn N recommendations based on corn N response data and corn and N fertilizer prices. This approach seeks to maximize economic return on N fertilizer use. The rationale and database for these guidelines, known as the maximum return to nitrogen (MRTN) approach, are described in the publication Concepts and Rationale for Regional Nitrogen Rate Guidelines for Corn (Sawyer et al., 2006). A web-based calculator for corn N rate guidelines using the MRTN is available at http://extension.agron.iastate.edu/soilfertility/nrate.aspx. Currently, N rate recommendations for corn

PSNT, ISNT, SPAD, etc...what does it all mean?

By Robert Mullen, assistant professor of soil fertility and nutrient management, The Ohio State University/Ohio Agricultural Development and Research Center (OARDC), Columbus OH

With higher fertilizers prices becoming the norm, scientists and producers alike are looking for alternative (hopefully better) methods of making nitrogen fertilizer rate decisions. Currently there are a number of methodologies promoted, but sometimes the scientific underpinning is lost in the discussion. The objective of this article is to provide information on how the methodologies are supposed to be utilized, where they have application, and where they have shortcomings. Various technologies will be discussed including the presidedress nitrate soil test (PSNT), the Illinois soil nitrogen test (ISNT), the use of SPAD meters, and the use of remote sensing.

PSNT

The PSNT was developed with the idea that nitrate levels could be measured prior to corn sidedressing as an indicator of N mineralization or N carryover from the previous year. As soil nitrate levels increase, the need for supplemental fertilizer should decrease. Research has demonstrated that at high levels of nitrate, the need for supplemental N does decrease (Fig. 1, page 8). The question then is what is the critical level that has to be achieved to ensure that N is not limiting?

There are several different statistical approaches that can be employed for determining that critical level. One of the easiest is simple evaluation of the data and selection of the PSNT level where there is a decreased risk of yield loss associated with N deficiency (level where relative yield approached 95%). For the data collected in Ohio over that last four years, the critical level would be around 30 ppm. Thus soils with PSNT levels above 30 ppm have a decreased risk of N deficiency and would likely not benefit from additional N inputs.

[continued on page 6]
Review of nitrogen placement for corn and soybeans

By John L. Havlin, Department of Soil Science, North Carolina State University, Raleigh, NC

As with any agricultural technology, the value of an input will often be site specific, where the application of and response to a particular management practice depends on factors that vary between locations or years. Nutrient management decisions should be fundamentally based on those site-specific factors that dictate a particular placement option for maximum productivity and profit, with minimal risk to the environment.

When evaluating nutrient placement options, it is critical to assess the underlying agronomic principles and reasons for the potential advantage of one placement method over another. Therefore, effectively documenting the value of a specific placement method by using selected supporting crop response data requires an adequate description of the mechanisms involved in the nutrient placement response. Understanding principles of nutrient reactions in soils and the relevant interactions among growing season environment (rainfall amount, pattern, etc.), crop factors (species, planting date, etc.), tillage and residue management, and other factors influencing plant vigor and productivity guide nutrient placement decisions.

Placement options, decision factors

The various placement options can be characterized by a simple matrix of application time by placement relative to the soil surface or seed (Fig. 1, page 10). Specific application times refer to before, at, or after planting, while placement is characterized by surface or subsurface application (foliar or fertigation options not shown).

Fertilizer cost

Fertilizer costs reached historic highs in recent years. Although recent changes in energy costs, product supply, and other factors will decrease fertilizer prices, the cost per unit of applied nutrient will likely remain higher than in the

Fulfilling the needs of the agronomic professional

By Mark Alley, President of the American Society of Agronomy; malley@vt.edu or 540-231-9777

After a 20-year hiatus, the American Society of Agronomy (ASA) restarted publication of Crops & Soils two years ago. The quarterly magazine has been well received by more than 15,000 certified professionals (CCAs, CPAs, CPSS/Cs) and around 1,500 undergraduate and graduate students. The primary purpose of the magazine is to help certified professionals enhance their knowledge base and skills by presenting timely technical information so that they can better serve their farmer clients. In addition, Crops & Soils provides a vital communication link among our certification holders, members, and ASA.

These days, the need for sound agronomic information is greater than ever as agriculture is being called on to solve some of the world’s most difficult problems, such as meeting the increasing demand for food, fuel, feed, and fiber. Starting with this issue, Crops & Soils will be published bimonthly to help certified professionals and their clients meet these demands. This increase is part of an effort to expand the scope the magazine and to increase support for CCAs, CPAs, and CPSS/Cs as they work with increasingly complex production systems.

The development of the ASA strategic plan identified the need to provide educational, research, and scientific information for agronomy professionals. To reach that goal, one initiative has been to restart publication of Crops & Soils magazine. As part of their certification, CCAs, CPAs, and CPSS/Cs will now receive this excellent publication six times a year. Crops & Soils is designed to provide a range of information across the breadth of agriculture along with the opportunity for practicing professionals to earn CEUs. The magazine provides an important link between agricultural research and its practical application in the field.

Educational programs are a major component of the strategic plan as well. ASA is now hosting monthly webinars. The first one was broadcast in February on sulfur deficiencies followed by a review of Manure Management Planner software in March, and slow-release fertilizers in April. ASA is also hosting an online, 12-week course called Basics in Applied Agronomy. The first course was held last fall, and due to its success, another one was started in February. The plan will be to host it again this fall. The demand is very strong for courses like this, so ASA will be developing more in the coming months.

If you have ideas for online educational programs or articles in Crops & Soils, please email them to lsmith@agronomy.org or call 608-268-4977. Our goal is to continue to add value to your certification.

www.agronomy.org
March–April 2009 | Crops & Soils
N credits for corn production | FROM PAGE 4

following soybean based on Indiana N response data can be obtained from this website.

Legume forages, legume cover crops, and manures

Established forage legumes can contribute most or all of the N needed by a following corn crop, and legume cover crops can provide smaller, but significant amounts of N. Given the current N fertilizer prices, the value of N credits for a previous forage legume crop can exceed $100 per acre. Nitrogen credits for forage legumes are influenced by crop species, stand density, and amount of top growth remaining when rotation to corn occurs (Laboski et al., 2006). Nitrogen in legume crops that may become available to a following corn crop is distributed throughout the top growth and root systems of the plants. Therefore, N credits for these legumes are influenced by the amount of growth present and removal of plant material through harvest.

Depending on nutrient availability and application rate, manures can also provide the entire corn N requirement. As with legume N credits, nutrients provided by manures have increased in economic value due to higher fertilizer costs. Since manures contain substantial amounts of phosphorus and potassium in addition to N, the value of typical manure applications is now substantial, and this makes accurate crediting critical for profitable corn production. Accurate crediting of manure N requires information on the rate of manure applied and on the availability of N in manure.

For most manure, the amount of N available to crops in the year of application is substantially less than the total amount of N in the manure. For example, only 50 to 65% of the N in typical liquid swine manure will be plant available in the year after application. Availability of N in manure is influenced by animal species, form of manure (solid or liquid), and method of application (surface, incorporated, or injected). University extension services in most states provide estimates of N availability and N credits for various manures. Local information on N availability in manures or manure analysis provides the best basis for crediting this N against corn N needs.

Nitrogen credits in soybean–corn, no-till corn–corn systems

Corn following soybean usually requires less N than corn following corn, and thus some adjustment in N rates is needed where soybean is included in the crop sequence. This soybean N effect differs from the N credits assigned for previous legume crops and manures in that soybean harvested for grain removes more N than the crop fixes from the atmosphere. Therefore, the soybean N effect is likely due to enhanced net N mineralization in soils rather than a direct N contribution from the soybean crop. The size of the soybean N contribution is usually 30 to 40 lb N/acre, and this amount is subtracted from the corn–corn N requirement.

With the emergence of the MRTN approach to making N recommendations, the soybean N effect can best be accounted for using N rate recommendations based on N response trials conducted with corn following soybean (Sawyer et al., 2006). Studies of factors influencing the soybean N effect show that soybean grain yield is not related to the apparent N contribution. Soybean residue management following grain harvest (residue removed or not removed) also did not influence the soybean N contribution. This observation lends support to the idea that the soybean N effect arises from increased net soil N mineralization in soybean–corn systems.

No-till corn following corn is more susceptible to slow early growth and N deficiency, especially in northern production areas. This suggests that no-till corn on corn could benefit from additional N relative to tilled production systems. Residue management research in no-till corn showed that corn residue removal or addition influenced soil temperature, which in turn, affected net soil N mineralization (Andraski and Bundy, 2008). An artificial residue treatment (polypropylene) performed similarly to normal corn residue with respect to soil temperature effects and soil N mineralization. Lower soil temperature rather than N immobilization by residue was the main cause of lower net soil N mineralization in the high-residue no-till system. Therefore, increasing N rates by about 30 lb N/acre may provide benefits in some years in no-till corn residue systems.

Soil nitrogen contributions

The most difficult N contribution to assess is the amount of available N supplied by the soil (N supplying capability, or NSC). This can be a significant component of the corn N supply with more than 50% of the crop N need coming from this source (www.agronext.iastate.edu/soilfertility/nutrienttopics/nitrogen.html). Although many N availability tests have been evaluated for predicting soil NSC, none have proven satisfactory. The emerging MRTN method of making corn N rate recommendations based on N response data and the economics of N and corn prices partially accounts for soil NSC since the average NSC is reflected in the corn N response database used to develop the recommendations. However, the
need remains to develop a site-specific technique to predict the amount of available N that the soil will furnish. Diagnostic tests such as the presidedress soil nitrate test (PSNT) can be useful for predicting corn N needs or assessing nonfertilizer N contributions. The PSNT has been found useful for predicting corn N needs particularly where contributions from legume forages and/or manures are expected. The PSNT critical value (20–25 ppm nitrate N) in the top foot of soil when corn plants are 6 to 12 inches tall is applicable across a wide geographic area, but the test is influenced by early-season soil temperature in northern production areas. In Indiana, the interpretation of PSNT results on 1-ft soil samples indicates that no additional N is recommended and no yield response is expected when PSNT values exceed 25 ppm nitrate N, and the full rate of N is needed when PSNT values are in the 0–10 ppm nitrate N range (Brouder and Mengel, 2003).

Once the amount of fertilizer N needed to optimize yields has been determined, management techniques such as source, timing, and placement of the fertilizer N can influence the effectiveness of the applied N. For example, fall-applied N has an average effectiveness that is 10–15% less than the same amount of N applied in spring, and surface applications of urea-containing fertilizers are subject to losses through ammonia volatilization that can range from 0–25%. Minimizing potential losses though effective use of management practices is key to optimizing economic returns from fertilizer N.

Summary

Increasing N fertilizer costs make accurate assessment of corn N needs more important than ever. The MRTN approach to corn N recommendations is the best way to identify corn N needs while simultaneously considering current corn and N fertilizer prices. Legume crops in rotation with corn and N in manures can supply important amounts of N for corn production. Previously, the N contributions from manures and legumes were often discounted or viewed as “insurance” nutrient inputs; however, current economics suggest that N from these sources should be carefully considered.

Where corn is grown in rotation with soybean, the reduced N need for corn should be accounted for either through crediting or by using N recommendations based on soybean–corn N response data. In no-till corn-on-corn systems, some additional N may be useful where soil temperature and soil N mineralization are reduced by the residue cover. Although soil N mineralization can supply a major portion of corn N needs, the size of this contribution is difficult to predict. Using corn N recommendations based on N response data will reflect the average soil N contribution. The PSNT can also be useful for confirming N contributions from legumes and manures and for assessing soil N mineralization. Once the amount of fertilizer N needed has been determined, use of management practices to control losses of applied N through ammonia volatilization or from fall N applications is essential.

This paper was originally presented at the 2008 Indiana CCA Conference in Indianapolis, IN in December. See www.indianacca.org/Conference/2008.

References


The next question is can one use the PSNT to determine the “optimum” N rate? There is a relationship between PSNT level and optimum N rate, and some universities do make recommendations based upon PSNT level. Evaluation of the relationship for 10 experiments conducted across Ohio does show a relationship, but it is not that great (Fig. 2). Notice that for a given PSNT level, the optimum N rate can have quite a wide range; thus Ohio State University does not make recommendations based upon PSNT levels. One could, however, adjust sidedress rate decisions downward as PSNT level increases—on average this should work.

One thing to note about the use of the PSNT is that it is most effective in situations where manure has been applied or where corn is following a leguminous forage crop. In most other situations, the PSNT level is well below the established critical level, and that is an indication that additional N is needed to ensure N sufficiency. Since we suspect that is the case anyway, why pay for the analysis?

The PSNT is a useful tool for making N rate decisions, but use it where it is most beneficial. It should be used where manure has been applied, corn is following a forage legume, or N carryover is suspected to be substantial. It can be used for sites that have received preplant N as well, but if the N was banded (like an anhydrous ammonia application or a starter application), there is a significant risk of getting a soil sample that doesn’t represent the actual soil conditions. Do not collect PSNT samples too early in the growing season. This is especially true in manured fields or fields coming out of legume forages. Early collection will usually have lower PSNT levels because the soils have not adequately warmed to allow mineralization to occur.

**ISNT**

This ISNT was first proposed by Mulvaney et al. (2001) based upon some research conducted in Illinois. They were evaluating soil organic matter for fractions that were easily mineralizable, and their research led them to the amino sugar N fraction of soil organic matter. This is a readily metabolizable fraction that they hypothesized could be used for estimating the amount of N mineralization potential based upon a lab procedure. Their initial research findings were encouraging as they showed that the ISNT could segregate between N responsive and nonresponsive sites (Mulvaney et al., 2001). They established a critical level between 225 and 235 ppm, so any soil that tested above 235 would be considered unlikely to respond to additional N application (Khan et al., 2001).

Other states began to evaluate the ISNT to determine if the proposed methodology could be adapted to different growing conditions. Iowa State University and the University of Wisconsin were among the first to evaluate the concept (Osterhaus et al., 2008; Laboski et al., 2008; Saw-
yer and Tabatabai, 2005), but their findings were not as positive as the original Illinois work. Both universities were unable to identify the critical amino sugar N concentration that Mulvaney and Khan had originally proposed. In fact, the work out of Iowa State and Wisconsin did not show a relationship at all between N responsiveness and amino sugar N content.

Since few have been able to replicate what was observed originally in Illinois, most land grant universities in the Midwest do not promote its use. Interestingly, North Carolina State University recently published a manuscript showing that the ISNT has some usefulness in their state for making N rate decisions (Williams et al., 2007).

**SPAD meters, optical sensing**

Recently, some researchers have begun to focus on the plant rather than the soil as an indicator of N release. Remember, N reactions in the soil are primarily biological in nature, so the speed and extent of mineralization is not only dictated by the organic material, but the weather conditions experienced during the growing season. Since scientists are unable to accurately predict weather conditions during the growing season, we have been unable to develop models to predict N availability as a result of mineralization. Instead of focusing on the soil and the inherent problems with modeling, an idea was borne that the plant could be used as an indication of what is going on in the soil during the growing season. We as agronomists have used plants in the past to indicate what is going on in the field through the use of tissue analysis, but this methodology is slow, labor intensive, and costly.

These ideas lead to the evaluation of optical sensors for determining in-season N response (Mullen et al., 2003; Varvel et al., 1997). The initial work was conducted in wheat with optical sensors and corn with SPAD meters, but optical sensors have been evaluated in corn as well (Fig. 3). In-season estimates of crop response can indicate responsiveness of the crop to additional N, but the use of a corresponding check strip (0 N) is a better indication of response than using an N rate lower than the reference strip. This was the first step in developing optical sensor–based algorithms (equations to determine N application rates).

There is a caveat to the use of a sensor. You must have an N reference or N-rich strip for comparison. For corn management, this obviously has a time factor. Currently, researchers promote that sidedress decisions be delayed to V6 or later prior to the utilization of this technology. Due to the small numbers of high-clearance sprayers and time constraints, the earlier the reference strip can be measured and used to calibrate N responsiveness, the better. Late-season readings have been shown to be more indicative of plant response than early-season readings. This makes sense considering early-season measures have only progressed through a fraction of the growing season after which things can change considerably.

There are multiple algorithms being formulated and evaluated. SPAD-based algorithms rely on relative SPAD readings (relative to a reference strip) and N response models to determine N application rates. Essentially SPAD meters are used to replace tissue testing as an indirect measure of tissue N concentration. Similar algorithms are being developed with active sensors as well. Alternative algorithms utilize a prediction of yield potential and N responsiveness. These algorithms depend upon on yield prediction models developed over many years and locations. The fundamental concept is to project yield potential with and without additional N to determine a N application rate.

So what is the status of these techniques to make N rate decisions? Some land grant universities utilize SPAD meters as improved N management tools (e.g., University of Nebraska and Penn State). The drawbacks with SPAD meters are the labor/cost issue and questions about the ability of the algorithms to perform adequately. Optical sensors are more attractive because they can be utilized in real time, but the technology is still quite expensive. Current research shows that in certain regions, the sensors can be used with good results (e.g., Oklahoma, Missouri, and Virginia). There is still hope that this technology can be transferred to other locations, but the first real step is establishing and utilizing reference strips.

This paper was originally presented at the 2008 Indiana CCA Conference in Indianapolis, IN in December. See www.indianacca.org/Conference/2008.

**References**


Review of N placement | FROM PAGE 5

last decade or less. It is relatively easy to assess the influence of fluctuating fertilizer and grain prices on optimum nutrient rates. Using known functional relationships between corn yield response to increasing N rate, economic optimum N rates can be quantified (Fig. 2).

With corn, the crop price:N cost ratio typically varies between 10:1 and 15:1 (i.e., 10:1 ratio results from $5.00/bu:$0.50/lb N). Under this range in price ratios, the N rate for maximum economic corn yield varies only slightly. However, when N fertilizer price increases significantly and crop price remains constant or decreases, the economic optimum N rate decreases. While optimum N rates depend on prices, it is important that as nutrient costs increase, the most efficient placement methods be utilized to ensure maximum crop response to applied nutrient. These often include band placement options.

N mobility, availability

Soil test interpretation for purposes of making nutrient recommendations is influenced by the mobility of the nutrient. With mobile nutrients like N, crop yield is proportional to the total quantity of nutrient present in the root zone. In contrast, yield response to immobile nutrients (P, K, etc.) is proportional to the concentration of nutrients near the root surface because these nutrients strongly interact with or are buffered by soil constituents.

In general, crop response to concentrated zone placement (band vs. broadcast) is enhanced with nutrients exhibiting strong soil-nutrient interactions. Obviously, crop responses to N, either broadcast or band-applied, will depend on numerous site-specific conditions. In addition, crop response to N placement varies greatly between years, as temperature and moisture influence soil biological processes (mineralization, immobilization, etc.) important to N availability.

Soil and tillage systems

Crop responses to nutrient placement are strongly influenced by cropping system, residue management, and numerous other factors that influence nutrient availability. For N, the principles inherent in crop response to N placement are best understood through evaluating the influence of N transformations on the fate of applied N. Depending on specific site characteristics (e.g., soil, crop, environment, management, etc.), crop responses to N placement depend on the proportional fate of applied N to N uptake and immobilization and, to a lesser extent, volatilization, denitrification, and leaching (Fig. 3).

For example, in reduced-tillage systems, significant N immobilization occurs depending on method of placement (Fig. 4). Although many factors can influence the degree of response among broadcast, surface band, and subsurface band applied N, the surface residue quantity and characteristics (e.g., C:N ratio) greatly influence immobilization of applied N and subsequent crop response to N placement.

Although surface tillage effects on crop response to N rate and placement are influenced by both residue type and quantity, subsurface N placement generally reduces fertilizer N immobilization, increasing fertilizer N recovery.

Crop responses to different N placement methods are also related to
site characteristics that favor N volatilization. While NH₃ production in soil is a natural product of the N mineralization process (Fig. 3), N volatilization losses of fertilizer N, while generally small, can be reduced through subsurface N placement. In addition, the effects of nitrification and urease inhibitors on reducing N losses and increasing fertilizer N recovery are well known.

**Starter applications**

Review of starter N placement responses can be frustrating since responses can be inconsistent. Crop response to starter fertilizer depends on soil test levels, tillage system, and proximity to the seed. As with most band placement methods, the probability of a starter response decreases with increasing soil test level. With medium-high soil tests, yield response to starters is often related to cool, wet conditions in fine-textured soils where early-season nutrient diffusion may not meet early plant growth demand. In addition, starter responses are often more frequent in conservation tillage systems where cool, wet soil conditions persist through the early crop growth period and N mineralization is substantially reduced. Starter N can be especially important with N management programs that include split N applications later in the season. If 20–30% more of total N is preplant applied, crop response to starter N can be reduced.

Producers should be careful with starter materials that include N, K, or some micronutrients (e.g., B), applied in direct seed contact. Seedling injury can occur if starter fertilizers are applied in direct contact with corn seed at >5–8 lb/acre N + K. The lower of these rates should be used in coarse-textured soils. Starter rates can be substantially increased if seed and fertilizer can be separated by 2 + 2 or other placement systems on the planter.

**Summary**

If a grower wants to know which N placement method will result in the greatest return on investment, the answer provided by the dealer or consultant should be based on the best scientific evidence supporting the specific placement method, provided the supporting data were obtained from a location with similar site characteristics as the site in question. Therefore, the most appropriate recommendation(s) must be developed from considerations specific to crops and cropping systems, numerous soil and crop management factors, environmental parameters, and any other factor that influences crop response to N placement.

This is a modified version of a paper that was originally presented at the 2008 Indiana CCA Conference in Indianapolis, IN in December. See www.indianacca.org/Conference/2008.

**References**


As a crop manager, you know your customers are relying on you to maximize their profits per acre.

In addition to maximizing yields and farm profitability, your fertilizer customers want to reduce any impacts on the environment. Using the right fertilizer source at the right rate, right time, and right place — the **4 R nutrient stewardship system** — is the key to achieving those economic and environmental objectives.

**Know Your Fertilizer Rights**, appearing in this month’s *Crops & Soils*, is the first in a five-part article series sponsored by The Fertilizer Institute (TFI), the Canadian Fertilizer Institute (CFI) and the International Plant Nutrition Institute (IPNI) that is designed to provide an explanation of the science behind the **4 R nutrient stewardship system**, as well as the environmental, economic and social benefits that come from making the right nutrient use decisions. For more information regarding the **Know Your Fertilizer Rights** article series and the **4 R nutrient stewardship system**, visit [www.ipni.net](http://www.ipni.net).

**Know Your Fertilizer Rights** includes a quiz that may be completed to earn continuing education credits.

Right Product @ Right Rate, Right Time, Right Place® is a trademark registered by the Canadian Fertilizer Institute on behalf of the fertilizer industry.
Earn 1 CEU in Nutrient Management

Editor’s note: This is the first article in a five-part series titled “Know Your Fertilizer Rights,” sponsored by The Fertilizer Institute and the Canadian Fertilizer Institute. The series is based on fertilizer best management practices structured around the “4R” nutrient stewardship concept. For more information, visit the International Plant Nutrition Institute website at www.ipni.net.

Know your fertilizer rights

By Tom Bruulsema, International Plant Nutrition Institute, Guelph, ON, Canada; Jerry Lemunyon, USDA-NRCS, Fort Worth, TX; and Bill Herz, The Fertilizer Institute, Washington, DC

This article describes a new, innovative approach to best management practices (BMPs) for fertilizer known as 4R nutrient stewardship. It ensures that the right source (or product) is applied at the right rate, right time, and right place. This simple concept can help farmers and the public understand how the right management practices for fertilizer contribute to sustainability for agriculture. Getting practices “right” depends on important roles played by many partners including farmers, crop advisers, scientists, policymakers, consumers, and the general public.

Sustainability

The increasing number and importance of issues surrounding the management of crop nutrients makes it necessary to have an approach that clearly describes the practices and their impacts. On the one hand, nutrient applications increase yields of crops, nourishing the world while sparing land for other uses and increasing the return of organic carbon to the soil, thereby sequestering a greenhouse gas. On the other hand, unmanaged nutrient applications may increase nutrient losses, potentially degrading water and air quality in a number of ways and possibly increasing greenhouse gases. Fertilizer use also has longer-term and larger-scale impacts on soil productivity and the social and economic structure of rural areas. These issues are all part of sustainable development.

The 4R nutrient stewardship concept is being developed because sustainable agricultural production is important, and we need to ensure that fertilizer use contributes to it. The fertilizer rights—source, rate, time, and place—are connected to the goals of sustainable development. Internationally, sustainable development is recognized to consist of three nonnegotiable elements: economic, social, and environmental. Progress in each of those three areas is essential to sustainability. How the progress will be achieved requires input from stakeholders. For fertilizer use to be sustainable, it must support cropping systems that provide economic, social, and environmental benefits.

The connection between the practices and the benefits must be understood well, not only by crop producers and their advisers, but also by those who purchase the products of cropping systems and those who live in the environment impacted by those systems. Programs involving payments to farmers for ecological goods and services—for example, carbon offsets related to greenhouse gas mitigation, loading reductions for water quality credit trading, etc.—depend on a clear public understanding of these linkages and a common language and vocabulary relating to fertilizer management.

Who decides what’s right?

Traditionally, a team of farmers, researchers, natural resource managers, extension staff, and agribusiness professionals—or a subset of this team—has decided what would qualify as a best management practice. Today there is still no doubt that the expertise of all these people is important to determining the right management on a practical basis. A sustainability-focused approach, however, is more...
comprehensive and includes input from all stakeholders in determining the indicators, measures, benchmarks, and targets for performance of the management practices implemented. So what’s right is determined by how these people want the cropping system to perform.

Stakeholders of cropping systems include the people who consume its products and the people living in the environment it impacts. The perspectives of all of these stakeholders must be reflected in the economic, social, and environmental goals that are set for the cropping system. Fertilizer management, to be considered “right,” must support those goals. All stakeholders have input to the goals. However, the farmer—the manager of the land—is the final decision maker in selecting the practices—suited to the local site-specific soil, weather, and crop production conditions—that have the highest probability of meeting the goals. Because all these conditions can influence the decision on the practice selected, right up to and including the day of implementation, local decision making with the right decision support information performs better than a centralized regulatory approach.

For example, a recent BMP guide for dairy-based cropping systems in the Northeast was developed using the input of farmers, agribusiness professionals, land grant university extension, and staff of the USDA-NRCS. Performance goals for farm profitability and off-farm impact on water quality were the foremost considerations of this body of experts, based on input from experience with environmental agencies, public interest groups, and policymakers. The BMP guide they developed listed 20 general practices under the categories of right source, rate, time, and place (Bruulsema and Ketterings, 2008).

What does it mean to apply the ‘right source at the right rate, right time, and right place?’

The phrase “right source at the right rate, right time, and right place” implies that each fertilizer management practice or group of practices is right—i.e., effective—in terms of the goals of sustainable production. It also implies that there are four aspects to every fertilizer application and provides a simple checklist to assess whether a given crop has been fertilized properly. Asking “Was the crop given the right source at the right rate, time, and place?” helps farmers and advisers identify opportunities for improvement in fertilizing each specific crop in each specific field.

A balance of effort among the four rights is appropriate. It helps avoid too much emphasis on one at the expense of overlooking the others. Rate may sometimes be overemphasized, owing to its direct relation to cost. Source, time, and place are more frequently overlooked and hold opportunity for improving performance.

The phrase also clearly describes to the fertilizer industry that farmers have specific requirements for the delivery and distribution of the right nutrient forms suited to their application equipment in the right amounts to support the right rate at the right time and to the right place. Meeting these logistical challenges is the fertilizer industry’s role in delivery and distribution.

Grouping specific practices associated with fertilizer management under the headings of source, rate, time, and place helps ensure that no critical steps in fertilizer management are overlooked. In that way, they are valuable to the farmer and the crop adviser. To ensure sound agronomy, the manager asks, “Am I using every tool available to choose the right product, to predict its right rate, to apply it at the right time, and to place it where it’s most effective for my crop, soil conditions, and weather?”

The four headings also help farmers, crop advisers, and agronomic scientists to clearly communicate with stakeholders less familiar with agriculture.

Are the four ‘rights’ independent or interconnected?

The four aspects of fertilizer management—source, rate, time, and place—are completely interconnected and also linked to the full set of management practices for the cropping system.

None of the four can be right when any one of them is wrong. It is possible that for a given situation, there is more than one right combination of source, rate, timing, or placement, but when one of the four changes, the others may as well. For example, it may be true for certain farms in a certain region that a single application of a controlled-release source of nitrogen (N) is equal in costs and benefits to a split application of a soluble N source. The two sources would obviously differ in the “right” time of application. They would be equally right if they achieved the same performance from the cropping system at the same cost. However, in many practical situations, one combination may be preferred over another because of a better fit with the logistics of the operation or with the range of weather risks to which each might be susceptible.

The four “rights” must work in synchrony with each other and with the surrounding plant-soil-climate and management environment. One change of step or direction may cause the entire system of nutrient management to fall short of its intended goal.

The combination of source, rate, time, and place changes depending on the crop management system as well. For example, a broadcast fertilizer application incorporated before planting may suit a corn–soybean rotation with tillage, but a band application and injection may be needed under no-till management. So the right source, rate, time, and place are interconnected, not independent, and are linked strongly to crop management and to local site-specific soil, weather, and climate conditions.

What scientific principles apply?

The sciences of physics, chemistry, and biology are fundamental to the mineral nutrition of plants growing in soils.
Time Assess dynamics of crop uptake, soil supply, and logistics of field operations. Determine timing of nutrient loss risks.

Place Recognize root-soil dynamics. Manage spatial variability within the field to meet site-specific crop needs and to limit potential losses from the field.

The application of these sciences to practical management of plant nutrition has led to the development of the scientific disciplines of soil fertility and plant nutrition. Each of the four management components of source, rate, time, and place has unique science describing fundamental processes. Science also studies and describes whole systems. Both levels of science are relevant because there are gaps in the knowledge of the fundamental processes and crop production systems or plant ecosystems are complex and can respond in unanticipated ways to the application of nutrients. So the science backing a particular practice needs to include both that which documents how the practice works at the basic level and that which measures the outcome in terms of changes in performance of the cropping system in which fertilizers are applied.

Specific scientific principles guide the development of practices determining right source, rate, time, and place. A few of the key principles are shown in Table 1. These and other important principles of plant nutrition will be described in more detail in the next four articles in this series.

The principles are the same globally, but how they are put into practice locally varies depending on specific soil, crop, economic, climate, and weather conditions. Agronomists and crop advisers make sure the practices they select and apply locally are in accord with these principles.

### What is performance and how is it assessed in implementing the four R’s?

Performance is the outcome of implementing a practice. The impacts of fertilizer management are expressed in the performance of the cropping systems or soil–plant–air ecosystems in which they are applied. Performance includes the increase in yield, quality, and profit resulting from a fertilizer application and extends to long-term effects on soil fertility levels and on losses of nutrients to water and air. It also includes impacts on the regional economy and social conditions—for example, affordable food. Not all aspects of performance can be measured on each farm, but all should be assessed. Planning indexes and computer models may be used for these assessments but need to be acceptable to stakeholders.

Performance is assessed through measures and indicators. It relates to all outcomes considered important to stakeholders (farmers, agribusiness, consumers, and the general public).

Performance measures are detailed measurements of the actual outcome of the implementation of a particular management practice to a particular cropping system. They can be very expensive and difficult to do. Performance measurements are done primarily by research agronomists and are used to validate management practices, often in a controlled field context designed to extrapolate to a large number of practical farm crop situations. An example may be a field trial on an experiment station in which two or more practices are compared and where measurements include crop yields, nutrient uptake, losses of ammonia and nitrous oxide to the air, losses of nutrients in runoff and drainage water, etc. The 4R concept helps guide research and extension toward validation of practices most relevant to achieving the economic, social, and environmental outcomes that stakeholders consider important.

Performance indicators are simpler measures that can be done on actual farms. Stakeholders need to agree that they reflect their aspirations for performance and that the indicators correlate well to actual measurements. For example, where soil erosion is a major issue and a large source of nutrient loss, an indicator measuring crop residues covering the soil at critical times may be suitable.

Since fertilizer applications have multiple impacts, no single measure or indicator provides a complete reflection of performance. Neither can all possible impacts be measured. Stakeholders need to select the performance measures and indicators that relate to the issues of greatest concern. A partial list of indicators from which they can select follows in Table 2. It is important to recognize that none of these is affected by fertilizer management alone. All can be improved by applying 4R nutrient stewardship, but they also depend on sound management of all practices applied to the cropping system or plant ecosystem. For instance, a good fertilizer program for turfgrass will not assure erosion control if clipping management, or species selection, is inappropriate.
Which are the most important performance indicators?

Crop managers or crop advisers cannot select the most important performance indicator on their own. Stakeholder input is required to select performance indicators representing progress on the goals considered important by all. It is often assumed that nutrient use efficiency is the most important indicator of performance for fertilizer use. This is not the case. Fertilizers are applied to increase the overall performance of the cropping system. Nutrient use efficiency is only one aspect of that performance, as indicated in Table 2. Nutrient use efficiency has many definitions, reflecting nutrient recovery, nutrient balance, or yield in relation to nutrients applied. Each provides unique indications of potential for improvement of fertilizer management, but none provides a full representation of the impact on overall performance.

In a nutshell, the 4R stewardship concept involves crop producers and their advisers selecting the right source–rate–time–place combination from practices validated by research conducted by agronomic scientists. Goals for economic, environmental, and social progress are set by—and are reflected in performance indicators chosen by—the stakeholders to crop production systems.

Reference

<table>
<thead>
<tr>
<th>Table 2. Performance measures and indicators for fertilizer management practices.†</th>
</tr>
</thead>
<tbody>
<tr>
<td>Performance measure or indicator</td>
</tr>
<tr>
<td>Yield</td>
</tr>
<tr>
<td>Quality</td>
</tr>
<tr>
<td>Nutrient use efficiency</td>
</tr>
<tr>
<td>Water use efficiency</td>
</tr>
<tr>
<td>Labor use efficiency</td>
</tr>
<tr>
<td>Energy use efficiency</td>
</tr>
<tr>
<td>Net profit</td>
</tr>
<tr>
<td>Return on investment</td>
</tr>
<tr>
<td>Adoption</td>
</tr>
<tr>
<td>Soil productivity</td>
</tr>
<tr>
<td>Yield stability</td>
</tr>
<tr>
<td>Farm income</td>
</tr>
<tr>
<td>Water and air quality</td>
</tr>
<tr>
<td>Ecosystem services</td>
</tr>
<tr>
<td>Biodiversity</td>
</tr>
<tr>
<td>Soil erosion</td>
</tr>
<tr>
<td>Off-field nutrient losses</td>
</tr>
<tr>
<td>Nutrient budget</td>
</tr>
</tbody>
</table>

† The relative importance among these and other indicators needs to be determined by stakeholder input.
March–April 2009
Self-Study Quiz

Know your fertilizer rights (no. SS 03853)

1. According to principles of sustainability, stakeholders need to provide input into selection of
   a. performance indicators.
   b. site-specific practices.
   c. source, rate, time, and place.
   d. sustainability goals.

2. Scientific principles guide the development of
   a. stakeholder teams.
   b. site-specific combinations of source, rate, time, and place.
   c. nitrous oxide emissions.
   d. sustainability goals.

3. Right source, rate, time, and place are
   a. independent among themselves and of other practices.
   b. interconnected but independent of other crop management practices.
   c. interconnected and linked to other crop management practices.
   d. independent of fertilizer management.

4. Fertilizer management practices should be validated by evaluating
   a. crop yield increases on research plots.
   b. crop yield increases in on-farm plots.
   c. economic, social, and environmental impacts in both research and farm plots.
   d. environmental benefits in both research and farm plots.

5. The final decision on selection of a site-specific combination of source, rate, time, and place should be made by
   a. regulatory authorities.
   b. the crop manager.
   c. a qualified research scientist.
   d. stakeholder teams.

6. The most important aspect of sustainable development is
   a. economic.
   b. social.
   c. environmental.
   d. a balance of the three.

7. A science-based fertilizer management practice is one that is
   a. based on past local experience.
   b. consistent with scientific principles and validated through field testing.
   c. specifically described in regulations.
   d. environmentally neutral.

8. The right combination of fertilizer source, rate, time, and place ensures the
   a. highest possible crop yields.
   b. minimum loss of nutrients to water.
   c. minimum loss of nutrients to air.
   d. best chance of achieving sustainability goals.

Quiz Continues
Next Page
9. The most important performance indicator of fertilizer management is
   - a. nutrient use efficiency.
   - b. crop yield.
   - c. crop quality.
   - d. determined by stakeholders.

10. Performance indicators reflect the progress of fertilizer management in helping to improve
   - a. water quality.
   - b. air quality.
   - c. crop yield.
   - d. sustainability.

**SELF-STUDY QUIZ REGISTRATION FORM**

Name: 

Address: 

City: 

State/province: Zip: CCA certification no.: 

$20 check payable to the American Society of Agronomy enclosed. Please charge my credit card (see below)

Credit card no.: Name on card: 

Type of card: 

Signature as it appears on the Code of Ethics: 

I certify that I alone completed this CEU quiz and recognize that an ethics violation may revoke my CCA status.

This quiz issued March 2009 expires March 2012

**SELF-STUDY QUIZ EVALUATION FORM**

Rating Scale: 1 = Poor  5 = Excellent

Information presented will be useful in my daily crop-advising activities: 1 2 3 4 5

Information was organized and logical: 1 2 3 4 5

Graphics/tables (if applicable) were appropriate and enhanced my learning: 1 2 3 4 5

I was stimulated to think how to use and apply the information presented: 1 2 3 4 5

This article addressed the stated competency area and performance objective(s): 1 2 3 4 5

Briefly explain any “1” ratings: 

Topics you would like to see addressed in future self-study materials: 

---

CONTINUING EDUCATION

Earn 1 CEU in Nutrient Management

Crops & Soils | March–April 2009

American Society of Agronomy
Evaluating organic soil amendments and fertilizer enhancers

By Carl R. Crozier, Ron Gehl, and Deanna L. Osmond, North Carolina State University, Soil Science Department, Raleigh

One of the roles of certified crop advisers and other professional agronomists is to make recommendations to clients regarding the effectiveness of specific products. This article discusses the potential role of certain types of organic products that do not supply nutrients and thus cannot be evaluated based on nutrient composition. Rather, these products attempt to alter soils or fertilizer products so that nutrient availability is enhanced in the soil or in the fertilizer product. Examples of these products include water soluble forms of mined humates and organic copolymers that serve as fertilizer N and P enhancers (Table 1).

Crop consultants and advisers should consider these products with an open mind, realizing that part of the ongoing change in agriculture involves adoption of new products and technologies or changes in application recommendations of existing products to improve yields and efficiency. Nevertheless, unwarranted or false statements and uneducated opinions should be avoided. Evaluation of product literature and comparative field trials, review of general soil fertility principles, and consultation with...
colleagues and independent researchers can all be useful in formulating recommendations.

Claimed value of these products

Thoroughly evaluate any product by reviewing both commercial advertisements and more objective technical labels and Material Safety Data Sheets (MSDS). Such documents should be available from the commercial distributors and are often accessible on the internet. Technical documentation can aid the user in understanding the basic chemical mechanism(s) for the product and can provide relevant information regarding scientific principles that explain the basis of product effectiveness.

For the types of products discussed in this article, the marketing literature describes the following potential benefits. Humic and fulvic acid products may increase soil cation exchange capacity (CEC); enhance particle aggregation, moisture-holding capacity, and soil organism populations; and may also directly stimulate plant root and overall growth and development, especially with foliar applications. Organic copolymer fertilizer enhancers may increase soil CEC, resulting in reduced availability of soil cations. This in turn may indirectly affect fertilizer N losses due to volatilization of ammonia and leaching of nitrate and may also affect fertilizer P availability due to a reduction of insoluble Al, Ca, and Fe complexes.

The claimed effectiveness of these products in agricultural soils is better understood by reviewing some basic soil science principles. Organic matter is known to be an important contributor to the soil CEC (Havlin et al., 2004). All of these products supply organic matter and thus could increase soil CEC. Supplementing soil CEC by adding these products could enhance binding of soil cations critical to fertilizer nutrient transformations or availability. Cation binding may reduce losses of soluble nutrients in the case of humic/fulvic acid products.

Organic copolymers can also cause cation binding, which may indirectly influence plant nutrition by reducing the availability of specific cations. Nickel (Ni^{2+}) is a component of the urease metalloenzyme (Ladd and Jackson, 1982; Martens and Westermann, 1991), and copper (Cu^{2+}) is a component of NH₃ mono-oxygenase, a nitrification enzyme (Voroney and Derry, 2008). Thus, binding of these cations by organic copolymers could contribute to delays to urease hydrolysis and nitrification. Enhanced binding of aluminum (Al^{3+}), calcium (Ca^{2+}), and iron (Fe^{3+}) by organic copolymers could reduce the availability of these cations to form insoluble P compounds (Havlin et al., 2004), thus potentially improving P fertilizer availability following additions of these types of products. In addition, some high-molecular-weight organic acids (especially humic and fulvic acid products) can have direct physiological effects on crops or soil organisms, such as enhancement of root initiation and elongation (Marschner, 1986). Regardless of these theoretical effects, inherently variable crop, soil, and environmental interactions will influence the overall effectiveness of a specific product in a given application.

Estimating product effects on measurable soil properties

Optimizing product effectiveness requires that the product have characteristics that will overcome an existing yield-limiting factor at the specific site of interest for a reasonable cost. Product, soil, and cropping system characteristics should all be considered. Since increasing the soil CEC is part of the expected mechanism of action of each of these products, the theoretical increase in CEC associated with recommended rates of each product is interesting to note. The following examples show it is highly unlikely that soil CEC can be substantially increased at typically suggested application rates.

In the following examples, the estimated increase in soil CEC is calculated based on soil and product data. For the purposes of this exercise, CEC of the products is estimated based on published CEC values typical of soil organic matter (Havlin et al., 2004). More accurate values can be substituted for each product if known.

**Example 1.** If 70 lb a.i./acre of a soil humic acid product (e.g., Table 1, product 1) is added to a sandy soil, the final soil CEC can be estimated as the weighted average of the two materials (soil, product). Assume 2,000,000 lb/acre of topsoil, a sandy soil with a CEC of 4 meq/100 g (or use value from a standard soil test report), and a product CEC of 250 meq/100 g (or use a product-specific value if known).

\[
\frac{(2,000,000 \text{ lb soil/acre} \times 4 \text{ meq/100 g}) + (70 \text{ lb a.i./acre} \times 250 \text{ meq/100 g})}{2,000,070 \text{ lb/acre}} = 4.01 \text{ meq/100 g}
\]

**Example 2.** If 1 lb a.i./acre of a seed-placed organic polymer product (e.g., Table 1, product 6) is added to a sandy soil, the final soil CEC in the fertilizer band zone (estimated as 0.1% of the bulk soil) can be similarly calculated as the weighted average of the two materials (soil, product). Assume 2,000 lb/acre of topsoil in the band zone, a sandy soil with a CEC of 4 meq/100 g (or use value from a standard soil test report), and a product CEC of 250 meq/100 g (or use a product-specific value if known).

\[
\frac{(2,000 \text{ lb soil/acre} \times 4 \text{ meq/100 g}) + (1 \text{ lb a.i./acre} \times 250 \text{ meq/100 g})}{2,001 \text{ lb/acre}} = 4.12 \text{ meq/100 g}
\]

While both of these are relatively small changes in soil CEC, note the greater potential change, even at a lower per-acre rate, if a banded application reduces the amount of soil interacting with the product. Note that this change in soil CEC only occurs in the fertilizer band zone and is unlikely to increase soil CEC in the bulk root zone or have residual effects for subsequent crops. Additionally, products are expected to have the greatest effect in soils with low initial CEC and in cropping systems with some yield-limiting aspect of nutrition sensitive to either leaching losses of soil cations (NH₄⁺, K⁺, Ca^{2+}, Mg^{2+}, Cu^{2+}, Mn^{2+}, and Zn^{2+}) or
complexation reactions with soil cations (i.e., Al\(^{3+}\), Ca\(^{2+}\), or Fe\(^{2+}\) phosphates).

For humic and fulvic acid products expected to increase soil humate content (e.g., Table 1, products 1 and 2), actual effects on soil humate content can also be estimated. Although soil organic matter content and composition are highly variable, rough estimates can be based on references from Brazil (Mendonca and Rowell, 1996), Canada (Schnitzer and Gupta, 1964), and the USA (Tan et al., 1972).

**Example 3.** If 70 lb a.i./acre of a soil humic acid product (e.g., Table 1, product 1) is added to a sandy soil with 1% organic matter, 60% of which is humates (i.e., 0.6% humate), the final soil humate concentration can be estimated as the weighted average of the two materials (soil, product). Assume 2,000,000 lb/acre of topsoil.

\[
\frac{(2,000,000 \text{ lb soil/acre} \times 0.006) + 70 \text{ lb a.i./acre}}{2,000,070 \text{ lb/acre}} = 0.00603 = 0.603\%
\]

**Example 4.** For a soluble humic acid product (e.g., Table 1, product 2) at 3 lb a.i./acre:

\[
\frac{(2,000,000 \text{ lb soil/acre} \times 0.006) + 3 \text{ lb a.i./acre}}{2,000,003 \text{ lb/acre}} = 0.006001 = 0.6001\%
\]

**Example 5.** If a solid humic acid product (e.g., Table 1, product 1) is applied to a seedbed or container medium at a rate equivalent to 10-fold higher than the per-acre rate recommended in Table 1:

\[
\frac{(200,000 \text{ lb soil or medium} \times 0.006) + 70 \text{ lb a.i./acre}}{200,070 \text{ lb mix}} = 0.00635 = 0.635\%
\]

Examples 3 and 4 suggest a miniscule increase in soil humate concentration, especially at the lower per-acre rate with the liquid product. Application of these products at typically recommended rates is not likely to significantly change soil humate concentration, even in well-drained soils with low organic matter content. In order to achieve substantial increases in soil humate content, much higher rates than those recommended on the product label may be needed, as in example 5.

For organic polymer products expected to improve N use efficiency (e.g., Table 1, products 3 and 4), greatest effectiveness is expected where reducing the rate of specific N transformations would be advantageous, i.e., to reduce NH\(_3\) volatilization losses following rapid urea hydrolysis and to reduce NO\(_3^-\) leaching losses following rapid nitrification. These include crops receiving relatively high N rates, crops receiving all fertilizer N at planting, surface application of urea to neutral or alkaline soils, and well-drained soils with low CEC.

For organic polymer products expected to improve P use efficiency (e.g., Table 1, products 5 and 6), greatest effectiveness is expected where P deficiency is likely
(e.g., low native soil P and very high or low pH soils) and where P fertilizer bands can be placed near the seed.

The feasibility of using these products should be compared with the feasibility of alternative strategies. Crop rotation, residue management, and soil conservation best management practices (BMPs) can lead to enhanced soil aggregation, infiltration, and moisture-holding capacity. Additions of manure and cover crops can increase soil organic matter concentrations while lime additions can increase soil CEC associated with variable-charge colloids. Crop N nutrition can be managed using optimal N rate, timing, source, and placement. In addition, other products are available with more direct effects on rates of N mineralization, urea hydrolysis, and nitrification. Crop P nutrition can be managed using soil test–based fertilizer recommendations and banded starter P. Nutrient deficiencies can often be detected through plant tissue analysis, which can lead to the selection of an improved nutrient management strategy for future crops.

Evidence needed to document product effectiveness

Numerous research studies have evaluated many of these products. However, due to the multiple products available and the vast differences in soils, crops, climate, etc., a thorough evaluation of product effectiveness in specific niches may not be available. Certified crop advisers and other professional agronomists should consult colleagues, researchers, and conference proceedings to determine what has been and is being done to evaluate these products in their respective areas or regions. In some cases, additional information will be available that is not provided in the marketing literature. In many cases, products described in this article are labeled such that fertilizer recommendations are not actually reduced, implying that the improved availability of nutrients in the soil will compensate for the additional cost of the products. Whether the grower will realize an economic benefit then will depend entirely on a positive yield response rather than reduced input costs.

The North Central Regional Research Committee, NCR-103, is an assembly of university and USDA researchers that provides unbiased, science-based information regarding the effectiveness of nonconventional/nontraditional products, soil amendments, growth regulators, and soil fertility programs. The NCR-103 committee has compiled a compendium of reports with information pertaining to a variety of nontraditional products, which can be used to aid in evaluating product effectiveness: http://extension.agron.iastate.edu/compendium/index.aspx.

With this uncertainty in mind, consider the following steps to evaluate any product:

1. Document the validity of the mechanism, i.e., will the product result in measurable changes to the soil? Verification of direct, nonnutritional effects on plants requires expertise in plant physiology, not just soil fertility, and is beyond the scope of this article.

2. Document yield response in appropriate field trials. This can be confusing, especially if some tests result in significant differences at a 0.05 probability level, some at a 0.1 probability level, and some result in no significant difference. Best professional judgement and the willingness of a client to assume risk need to be considered.

3. Evaluate suitability based on product cost, application rate, yield limitations in the specific cropping system, region a specific product has been tested in, and expected agronomic benefit. Product suitability should also be compared with the cost of applying alternative sources of nutrients, lime, or organic matter that might resolve similar yield limitations.

Summary

Certified crop advisers and other professional agronomists need to provide appropriate recommendations that are free from unwarranted or uneducated opinions regarding products marketed to their clients. While there are many potential benefits of organic soil amendments, their usage in large-scale field operations should be carefully scrutinized based on knowledge of the product composition and mechanism of action. Certain products may only be effective when applied in relatively high concentrations to narrow fertilizer bands, seedbeds, or container-grown plants. Product suitability for a given application should be based on likelihood of profitable yield response in the specific system and geographic region under consideration.

References


March–April 2009
Self-Study Quiz

Evaluating organic soil amendments and fertilizer enhancers (no. SS 03864)

1. The process of evaluating soil amendments should include evaluation of product literature and comparative field trials, review of general soil fertility principles, and consultation with colleagues and independent researchers. Specifically, an adviser should

☐ a. consult the opinions of internet blogs and company representatives.

☐ b. evaluate commercial advertisements, objective technical labels, and Material Safety Data Sheets (MSDS).

☐ c. use his/her own judgement and ignore advertisements.

☐ d. only read technical articles done by professional scientists.

2. Technical documentation can aid the user in understanding

☐ a. the basic chemical mechanism(s) and the scientific principles of the product.

☐ b. why the product should be used only in certain conditions.

☐ c. the specific agronomic application(s) of the product and yield advantages associated with its use.

☐ d. why certain amendments can be harmful.

3. For the types of products discussed in this article, the marketing literature describes the following potential benefits:

Humic and fulvic acid products may increase soil CEC; enhance particle aggregation, moisture-holding capacity, and soil organism populations; and may also directly

☐ a. stimulate plant root and overall growth and development, especially with foliar applications.

☐ b. increase plant fiber content, especially in combination with organic copolymers.

☐ c. alter plant maturity, especially in combination with weather anomalies.

☐ d. stimulate plant size and mass, especially when applied directly to the soil.

4. Organic copolymer fertilizer enhancers may increase soil CEC, resulting in reduced availability of soil cations. This may

☐ a. affect fertilizer N losses due to volatilization of ammonia and leaching of nitrate.

☐ b. affect fertilizer P losses due to an increase of soluble Al, Ca, and Fe complexes.

☐ c. increase insoluble Al, Ca, and Fe complexes.

☐ d. increase retention of fertilizer content.

5. Cation binding may reduce losses of soluble nutrients in the case of humic/fulvic acid products. Organic copolymers can also cause cation binding, which may

☐ a. indirectly influence plant nutrition by reducing the availability of specific cations.

☐ b. have mixed effects, reducing availability of specific cations and having no effect on others.

☐ c. indirectly influence plant nutrition by increasing the availability of specific cations.

☐ d. have little effect on plant nutrition.

6. Some high-molecular-weight organic acids (especially humic and fulvic acid products) can have direct physiological effects on crops or soil organisms, such as

☐ a. stronger stems.

☐ b. enhanced root initiation and elongation.

☐ c. later maturation.

☐ d. lighter-colored leaves.

7. The feasibility of using these products should be compared with the feasibility of alternative strategies. Which is NOT an alternative strategy mentioned in this article?

☐ a. No-till management.

☐ b. Crop rotation, residue management, and soil conservation best management practices.

☐ c. Additions of manure, cover crops, and lime.

☐ d. Plant tissue analysis.

Quiz Continues

Next Page
8. Three steps should be used when deciding whether to recommend specific products. The first step is to document the validity of the mechanism, i.e., will the product result in
   a. measurable changes to the soil?
   b. measurable changes in yield?
   c. measurable changes in biomass?
   d. better water retention?

9. The second step is to document yield response in appropriate field trials. This can be confusing, especially if some tests result in significant differences at a 0.05 probability level, some at a 0.1 probability level, and some result in no significant difference. Best professional judgement should be combined with
   a. a gut feel.
   b. the willingness of a client to assume risk.
   c. the recommendation of the local extension agent.
   d. the claims of the manufacturer.

10. The third step is to evaluate suitability based on product cost, application rate, yield limitations in the specific cropping system, region a specific product has been tested in, and expected agronomic benefit. Product suitability should also be compared with the
   a. cost of doing nothing compared with the cost of yield reduction.
   b. cost of applying alternative sources of nutrients, lime, or organic matter that might resolve similar yield limitations.
   c. cost of similar brands of a product that might be somewhat different.
   d. cost and advantages of increasing application rates.

---

**SELF-STUDY QUIZ REGISTRATION FORM**

Name: 

Address: 

City: 

State/province: Zip: CCA certification no.: 

☐ $20 check payable to the American Society of Agronomy enclosed. 

☐ Please charge my credit card (see below) 

Credit card no.: 

Name on card: 

Type of card: ☐ Mastercard ☐ Visa ☐ Discover ☐ Am. Express 

Expiration date: 

Signature as it appears on the Code of Ethics: 

_I certify that I alone completed this CEU quiz and recognize that an ethics violation may revoke my CCA status._

*This quiz issued March 2009 expires March 2012*

---

**SELF-STUDY QUIZ EVALUATION FORM**

Rating Scale: 1 = Poor  5 = Excellent

Information presented will be useful in my daily crop-advising activities: 1  2  3  4  5

Information was organized and logical: 1  2  3  4  5

Graphics/tables (if applicable) were appropriate and enhanced my learning: 1  2  3  4  5

I was stimulated to think how to use and apply the information presented: 1  2  3  4  5

This article addressed the stated competency area and performance objective(s): 1  2  3  4  5

Briefly explain any “1” ratings: 

Topics you would like to see addressed in future self-study materials: 

---
Job seekers, are you ready to find your next career opportunity? Employers, are you looking for the next addition to your team? Then check out the new and improved ASA–CSSA–SSSA Career Placement Center at www.careerplacement.org.

Job seekers

Job seekers can post resumes free of charge for certified professionals (CCA, CPAg, CPSS, and CPSC) and ASA–CSSA–SSSA members through our easy-access submission site. They can also create more than one resume to target different job opportunities and select categories for employers to conduct resume searches. These categories include certifications held, education and job level, the type of employment desired, and relocation preference. But that’s not all—resumes can be searched based on any criteria in your resume.

To post your resume and search jobs, visit www.careerplacement.org. For more information, call 608-268-4949 or email lmalison@agronomy.org.

Employers

Ready to find the perfect employee, the one with the skills, education, and experience you need? Search our resume database and find that qualified practitioner and agronomic, crop, soil, or environmental professional. Resumes can be searched using a wide range of criteria, so you can find the right individual to match your position. You can also browse all the resumes posted by the date submitted.

You may also post job openings online and through our monthly CSA News magazine. It’s more cost effective than the big, national job sites and focused exclusively on ag-related, experienced professionals. For rates and more information, contact Melissa Fall at mfall@agronomy.org or 608-268-4972. Have a variety of job openings? Consider a new display ad here in the Career Center page of Crops & Soils magazine. Contact Alexander Barton at abarton@2bartons.com or 847-698-5069.

To search resumes and post job openings, visit www.careerplacement.org. For more information, call 608-268-4949 or email lmalison@agronomy.org.

Position Announcement

Laboratory Agronomist

Provide technical support and marketing services for a leader in the agricultural and environmental laboratory industry. As a member of the agronomic services team, candidate will assist in maintaining and developing business relationships by providing clients with pertinent information and practical advice related to our laboratory analyses.

Desired Qualifications:

- Advanced degree in agronomy, soil science or related academic discipline. Will consider B.S. with appropriate background.
- Knowledge of soil fertility and plant nutrition aspects related to the diverse crops grown in the Great Lakes region.
- Personality conducive to developing strong business relationships.
- Experience in developing and delivering educational presentations and materials.
- Effective communicator in both group and one-on-one settings.

Quality Analyses for Informed Decisions® is our company motto. We are searching for the right individual to help maintain and grow our business in a manner supportive of this guiding principle. Working with our diverse client base and helping meet their varied needs offers challenges and opportunities for professional growth and development.

Seasonal overnight travel required - company vehicle provided. Competitive compensation package includes salary, health insurance, 401(k) (with company match), profit sharing, vacation and other benefits.

Please send a cover letter and resume to:

Randall Warden
A & L Great Lakes Laboratories, Inc.
3505 Conestoga Drive
Fort Wayne, IN 46808-4414
rwarden@algreatlakes.com
Phone: 260-483-4759
FAX: 260-483-5274

www.algreatlakes.com • lab@algreatlakes.com
Continuing education for today

As certified professionals, you are continually searching for top quality continuing education programs—quality not just in terms of content, but also in delivery. We have all experienced great programs with dynamic speakers addressing topics we’ve wanted to learn more about that have helped us serve our clients better. However, we have all experienced the opposite of that as well, but we want to focus on the good and hopefully make it better.

Webinars

The American Society of Agronomy (ASA) and Soil Science Society of America (SSSA) began broadcasting monthly webinars in February. The first topic was sulfur deficiency in crop production, presented by Dr. John Sawyer, CCA, Iowa State University. Dr. Brad Joern from Purdue University presented the second webinar in early March on nutrient management planning with the latest USDA and USEPA approved tool—Manure Management Planner. On April 1, the topic will be slow-release fertilizer, presented by Dr. Greg Schwab, CPAg, University of Kentucky. May begins a series on the “4 rights” concept being delivered by IPNI scientists in conjunction with the first article in the series contained in this edition of Crops & Soils magazine (see page 13).

The purpose of the webinars is to deliver science-based, timely information that provides continuing education but also information that can be used to serve your clients and customers. Through this, ASA and SSSA hope to add value to being certified.

The webinar format allows the content to be viewed from any location that has a computer with a high-speed internet connection, offering topics by instructors that you may not otherwise hear from. The live sessions are worth 1 CEU and are archived after the session in the CCA self-study CEU section of the website (www.certifiedcropadviser.org/certified/education/self-study). ASA will send out notices several weeks prior to the webinar, and they do require advance registration.

Online vs. print CEUs

Each issue of Crops & Soils magazine features self-study CEUs. CCAs can earn up to 20 CEUs of their required 40 as self study. As you have probably noticed if you have taken advantage of the self-study CEUs, there are two different prices depending on how you complete the quiz, online or print. It is naturally less expensive for ASA to process online quizzes compared with print versions that are mailed to ASA; hence we pass the savings on to you.

There is an ongoing debate of whether or not we should even print the quizzes in the magazine or just direct readers to the website. We could print the article in the magazine but then direct readers to the website to take the quiz and earn their CEUs. That would save both you and ASA some money, and we could use those vacated pages to provide you with some other news and information that we didn’t have space for before.

I have heard over the years from many CCAs that they like everything contained in the magazine because it is 100% portable. You can access the magazine anywhere, anytime. Lunch break in the pickup, you can pull out the magazine, read the article, and complete the quiz even if you later decide to save $5 and a stamp by submitting it electronically to ASA via the website. It makes a lot of sense for a highly mobile group. Accessibility is important, and we don’t want to diminish that in any way but it is less costly using the web version.

We’d like to ask your help in settling this debate. Please take a minute and send an email to cropsandsoils@agronomy.org and tell us if you want us to keep printing the self-study CEU quizzes in the magazine or just have them online. Just type “Keep” in the subject line if you want us to keep printing the quiz or “Dump” if you don’t or don’t care. Thanks for your help, and we will respond accordingly.

Basics in Applied Agronomy

ASA offered for the first time last fall an online course titled Basics in Applied Agronomy. It was a huge success with more participants than we had room for, so we offered the course again starting in February. This second offering was motivated by the University of Arkansas’ desire to build it into its senior capstone course. ASA agreed to pilot-test the approach but also opened it up to others. Again, there was a huge response from those working towards becoming certified that generated a long waiting list for the next offering.

The course is designed for people starting their career who want to become certified. It covers the performance objectives of the ICCA exam but takes a very practical, applied
Exams, international expansion

The February CCA exam date had the highest number of examinees in recent years. There were 13% more examinees than in 2008, and 2008 was 10% higher than 2007. Typically exam numbers are an early indication of program growth. The soils exams saw a 25% increase in examinees in 2008, so numbers were up in both professions.

International expansion for the ICCA Program into India and Argentina continues in discussions. In April, Letters of Agreement will be signed for India, and the first training and organizing meetings will be held. Argentina will follow in May. Both countries are very interested in joining the ICCA Program and adding certification standards for those who advise farmers. The first exams will be delivered in June–July of 2010 with the potential of adding 3,000 to 5,000 CCAs by 2012. More details will follow in upcoming issues of Crops & Soils magazine.

Universities

We continue to work with university departments to offer the ICCA and/or soils fundamentals exams to their senior students in agronomy and soil science. Purdue University became the first to host an exam site for students during the February offering of the CCA exams. The University of Arkansas became the first to incorporate the Basics in Applied Agronomy course in its senior capstone and will offer the ICCA exam during finals week. We will continue to talk with other schools as interest grows.

Certification

Newly certified

The following list includes newly certified individuals and those that have added additional certifications since the last issue of Crops & Soils. The list is alphabetized by state/province and by surname within each state/province.

Canada

- Dargis, Lynn, St. Vincent, AB (CCA-PP)
- Ekkel, Jeffrey, Lacombe, AB (CCA-PP)
- Gemmell, Michelle, Rycroft, AB (CCA-PP)
- Pollack, Merle, High Prairie, AB (CCA-PP)
- Sachko, Crystal, Lethbridge, AB (CCA-PP)
- Templeton, Lisa, Acme, AB (CCA-PP)
- Anderson, Stephen, Killarney, MB (CCA-PP)
- Friesen, Gerry, Morris, MB (CCA-PP)
- Nowosad, Trenton, Hamiota, MB (CCA-PP)
- Parsonage, Jeff, Baldur, MB (CCA-PP)
- van Meijl, Wilco, Rapid City, MB (CCA-PP)
- Cowan, Allan, Exeter, ON (CCA-ON)
- Garrod, Chad, Guelph, ON (CCA-ON)
- Hodgins, Greg, Feuersham, ON (CCA-ON)
- Kraus, Trevor, Vankleek Hill, ON (CCA-ON)
- McCormack, Laura, Rockwood, ON (CCA-ON)
- McFarlane, J.D., London, ON (CCA-ON)
- Tomecek, Joseph, Chatham, ON (CCA-ON)
- Warwick, Robert, Bluevale, ON (CCA-ON)
- Whittington, Darryl, Ingersoll, ON (CCA-ON)
- Carley, Chadrick, North Battleford, SK (CCA-PP)
- Darragh, Naomi, Turtlesford, SK (CCA-PP)
- Erickson, Douglas, Rosetown, SK (CCA-PP)
- Ferguson, Chad, Naicam, SK (CCA-PP)
- Jones, Jeremy, Gainsborough, SK (CCA-PP)
- McKee, Terrance, Moose Jaw, SK (CCA-PP)
- Middelkoop, Trevor, Regina, SK (CCA-PP)
- Taylor, Janel, Outlook, SK (CCA-PP)

United States

- Ebbecke, Daniel, Masaryktown FL (CCA-FL)
- Walker, Dean, Moscow, ID (CCA-NW)
- Bunting, George, Carmi, IL (CCA-IL)
- Davis, Tadgh, Petersburg, IL (CCA-IL)
- Meece, Kyle, Monticello, IL (CCA-IL)
- Harris, Paul, Jonesville, LA (CCA-LA)
- Benda, Tom, Pine Island, MN (CCA-MN)
- Kraska, Kyle, Elk River, MN (CCA-MN)
- Lorentz, Jeffrey, Maple Lake, MN (CCA-MN)
- Sammon, Storm, Owatonna, MN (CCA-MN)
- Weber, Brad, Mankato, MN (CCA-MN)
- York, Lee, Lake Wilson, MN (CCA-MN)
- Caldwell, Keith, Newton, NC (CCA-NC)
- Gouniak, Joseph, Phillipsburg, NJ (CCA-PA)
- Richtmyer, Richard, Watkins Glen, NY (CCA-NR)
- Everett, Troy, Longdale, OK (CCA-OK)
- Whitney, Kevin, Anadarko, OK (CCA-OK)
- Campbell, Jonathan, Elizabethville, PA (CCA-PA)
- Longenberger, Carl, Manheim, PA (CCA-PA)
- Rotz, Jonathon, Carlisle, PA (CCA-PA)
- Bishop, Thomas, Kingstree, SC (CCA-SC)
- Compton, Stephen, West Union, SC (CCA-SC)
- White, David, Pamplico, SC (CCA-SC)
- Lowery, Albert, Newbern, TN (CCA-TN)
- Moore, Ryan, Oakfield, TN (CCA-TN)
- Redding, Christian, Bells, TN (CCA-TN)
- Spence, William, Union City, TN (CCA-TN)
- Kuhnke, Richard, Zenda, WI (CCA-WI)
- Mulder, Michael, Oshkosh, WI (CCA-WI)
Meet the professional: Janet Fallon

It was fitting last fall when Janet Fallon was recognized as CCA of the Year for the Northeast region because she’s been working tirelessly the last couple years to build greater recognition of the CCA program. Two years ago, she approached Country Folks, a weekly farm newspaper that’s distributed throughout much of the Northeast, and convinced it to create a quarterly CCA section. Fallon manages, edits, and writes for the section, which includes contributions from CCAs, farmers, and university personnel from different parts of the region.

“It’s a nice way to get the message out about CCAs and create awareness,” explains Fallon, a CCA who provides technical sales support for Dairy One, a milk-, forage-, and soil-testing laboratory headquartered in Ithaca, NY. “We’ve been doing it for about two years. I’m sort of the wonder whip, I guess, because I call people and nag them into submitting articles.”

Fallon’s persistence has paid off, according to Shawn Bossard, a fellow CCA and chair of the Northeast region board, who has worked with her on a number of projects.

“The impact from this quarterly insert has been huge,” says Bossard, Cornell Cooperative Extension Director for Seneca County, NY. “Our CCA December training attendance doubled in one year’s time!”

Bossard adds that Fallon herself has had quite an impact on the region, both at Dairy One for the last five and a half years and at Agway Inc. for 26 years before that.

“The magnitude of the impact of Janet’s body of work is huge in the Northeast. Her recommendations reach out across state lines.”

Not just state lines, but country lines as well. While most of Fallon’s customers are consultants, feed mills, veterinarians, and universities in the Northeast, Dairy One serves all 50 states and 37 foreign countries as well.

“So far, the only foreign country they’ve let me visit is Canada,” Fallon laughs. “I’d love to visit customers in Japan or someplace more distant than Canada.”

A growing soils division

Right now, Dairy One needs Fallon a little closer to home, helping its relatively new soils lab grow. Last year, the University of Vermont’s soils lab closed, and Fallon has spent a lot of time there getting customers up and running with a Dairy One program. This spring, the commercial side of Cornell’s soils lab will be transferred to Dairy One under a new venture called Agro One.

“This transition will allow Cornell researchers to spend more time on research and development of new soil-testing technologies,” Fallon explains. “Cornell will continue to process its research samples in house, providing an avenue for future soil scientists to gain hands-on analytical experience as well.”

Fallon can certainly attest to the importance of hands-on training early in a career. She recalls her own experience as a recent Cornell graduate going to work at Agway.

“I had the lucky position of sampling every skid steer load of manure coming out of a 600-ton storage because we had a big USEPA manure management grant at the time. It was a good experience, but I’m glad I’m older and other people can do that stuff now,” Fallon laughs. “It was a good place to get a start because we were doing all kinds of research there—manure management, vegetable management, forage variety development—a lot of different things. It really gave me a good foundation in a lot of different areas. I had a chance to do hands-on work—including some in situ and in vitro digestibility work. After sticking your arm up to your elbow into a cow’s rumen to collect rumen fluid, you really appreciate being an agronomist!”

And Fallon’s customers certainly appreciate her and her colleagues at Dairy One, who process more than 125,000 forage samples a year for them.

“For forage analysis, [customers] use the information to balance rations on farms. This is needed to optimize animal production, health, and profits. It’s important to know what’s in your feed, so that you can avoid costly overfeeding or underfeeding.”

She says most of the forage analysis is done using near infrared (NIR) technology, but they use wet chemistry as well depending on the type of feed and customer needs. At the soils lab, the number of samples processed continues to increase as it enters its fourth year of operation, Fallon says. The lab offers a Modified Morgan analysis (for its Vermont customers), a Mehlich 3 analysis, and will soon offer a wet chemistry Morgan analysis for its New York customers who prefer the wet chemistry values over the calculated Morgan values. Results are currently available by email, fax, or U.S. mail and will soon be available to customers from a searchable database online.

“With soil testing, we provide recommendations that are fairly generic because we recognize that the consultant knows more of the history of that farm, the farmer’s abilities and budget, and whether there are environmental issues to factor in,” Fallon says. “That is where the CCA can really shine—by customizing recommendations to provide farm-specific guidelines that will meet farmer and environmental needs.”

Academic, experience credentials

Fallon feels the CCA program keeps consultants up to date and helps reassure farmers that their consultant’s advice is sound.
“I feel that it’s important to make sure that people are up to date on the latest technology and products. Maintaining my CEUs in the different categories helps me be better rounded because you really have to understand the whole integrated process of producing a high-quality crop and protecting the environment. It’s very important to have standards for the industry as a whole to abide by and to provide farmers and the nonfarm community with some reassurance that their crop consultants have the academic and experience credentials to make good recommendations.”

Fallon also works with students who are in the process of building up their academic credentials. As a Cornell Alumni Admissions Ambassador, she interviews local high school students who are applying to Cornell.

“It’s really a fun process because you have a chance to talk to kids who have done a lot of interesting, amazing things, and they’re only 17 years old. It’s frustrating when you have a kid who you really think is great, and they don’t get [accepted]. There’s just so much competition—nearly 30,000 applicants for 3,000 spots. It’s a rewarding process, and it keeps me in touch with the university and what’s going on there.”

Fallon says students with ag degrees are in demand as many industry employers say it’s increasingly difficult to find new employees who have one. And certification can help a recent graduate stand out from all of the other applicants with similar degrees.

---

**NAPT working for you**

**Challenging your laboratory**

*By Donald A Horneck, extension agronomist, Oregon State University Extension Service, Hermiston, OR*

As a CCA, you depend on reliable soil test results when giving advice to clients. If you want to evaluate laboratory performance, I suggest three easy ways to challenge your laboratory:

1. Ask to see its NAPT results.
2. Ask for a sample that has been already analyzed by your laboratory and resubmit it on some occasional basis.
3. Purchase a check sample from NAPT that fits the range of soil test values you normally deal with.

Most laboratories participate in an external program that helps them judge the accuracy of their data. NAPT (North American Proficiency Testing Program), operated by the Soil Science Society of America, is the premier program in North America. Checking how a laboratory performs on its NAPT samples allows you to assess its performance compared with other laboratories across the country. A laboratory will not pass with 100% accuracy, but it should perform well.

A great way to test your laboratory yourself is to ask it for the return of one of the samples you have submitted. You could do the same thing by keeping part of the sample as collected for later submission, but there is always uncertainty about how well the sample is mixed, dried, stored, etc. Using the sample that the lab has dried, ground (mixed), and analyzed allows for a more unbiased sample. When lots of samples are submitted, it also allows you to choose a sample that has values of concern to you. This sample needs to be requested from the laboratory shortly after analysis, as many only store their analyzed samples for a short time. Small portions of a requested sample that has been dried and mixed can then be re-submitted at a later date or sent to another lab for comparison.

Purchasing a prepared sample (www.naptprogram.org/soilsale) from NAPT is relatively inexpensive (roughly $50). Dr. Janice Kotuby-Amacher, NAPT Coordinator, can help you get a soil that has the characteristics commonly observed in your soil tests (call 435-764-7643 or email jkotubymendel.usu.edu).

Interpretation of analyses from the same sample is not always easy. First think about agronomic range and then sample variability. Fertilizer recommendations come in three broad classes (Yes, Maybe, or No) as to fertilizer requirements. When a sample analysis gives a “Yes” one time and a “No” the next, variability is too high. When the samples keep coming back “Yes” even though there is a 100% variance, the analysis is still good; e.g., 1 ppm, 2 ppm, and 3 ppm for three consecutive analyses, though having a high CV%, the analysis is acceptable. Second, when an analysis is in the medium or high range, 10% or better is a reasonable amount of variability to expect for most soil tests; results of 100 ppm, 90 ppm, and 110 ppm would be acceptable.

Challenging your laboratory lets it know you are watching, and you will both be better for it.
Fertilizer additive

In 2007, Specialty Fertilizer Products (SFP) introduced NutriSphere-N, which it says increases nitrogen use efficiency the entire growing season by acting as a nitrogen fertilizer manager.

“Improving yield potential and grower return on investment is always our ultimate goal,” says Dr. Larry Sanders, SFP President and CEO. “NutriSphere-N for nitrogen fertilizer uniquely overcomes age-old management challenges for growers—nitrogen volatilization and leaching.”

When urea (dry nitrogen fertilizer) or urea containing liquid UAN comes into contact with the naturally occurring enzyme urease on the soil surface, urease works to break down urea into a state that can volatilize a large percentage of the applied nitrogen, leaving little nitrogen available to the crop. Similarly, when nitrogen fertilizer (dry or liquid) is added to the soil, leaching of nitrate nitrogen can be a significant problem depending on environmental and soil conditions.

NutriSphere-N is an additive for dry and liquid nitrogen fertilizer. SFP claims that it works in the soil at the molecular level to prevent leaching and volatilization by creating an active shield that manages nitrogen in the soil. This shield prevents the action of urease in volatilization and slows nitrification reactions, which lead to nitrate leaching, and allows the plant better access to stable forms of nitrogen throughout the growing season. SFP says this process gives the plant greater access to applied nitrogen without destroying the spectrum of naturally occurring soil bacteria and enzymes.

“Each crop has unique nutrient needs,” Sanders says. “The season-long effects of NutriSphere-N ensure a crop has access to the nitrogen it needs—when it needs it—to maximize growth potential, no matter what the soil conditions.”

Adds Sanders: “NutriSphere-N works to protect growers’ nitrogen investment by keeping nitrogen where it belongs—in the soil and available to the plant.”

NutriSphere-N joins AVAIL, a phosphorus-fertilizer enhancer, in a line of fertilizer-enhancing products manufactured by SFP. For more information on NutriSphere-N, call 888-446-GROW or visit www.NutriSphere-N.com. Growers can also contact their local fertilizer distributor or dealer to learn more about the product.

Irrigation efficiency device

A device made by Aqua-PhyD for improving irrigation efficiency was named one of the top 10 new products at the 2009 World Ag Expo held in February in Tulare, CA. The device fits into the main line of drip, sprinkler, or flood irrigation systems and allows growers to stretch limited water supplies without chemicals and without extra electrical power. The unit measures 48 inches long and, depending on size of pipeline, about 12 inches in diameter. It is mounted between the sand filters and before the line goes into the ground.

“Aqua-PhyD optimizes soil structure and increases mineral and nutrient uptake without chemicals,” says Jerry Rai, the company’s director of agriculture.

“The technology exploits quantum electrodynamic processes to transfer energy into the water passing through the unit. As a result, potential energy stored within the water is significantly enhanced. When that water hits the soil, the stored potential energy is released, opening up soils and improving infiltration and percolation of water.”

He describes results in one field trial of a compacted soil where he used a compaction meter to measure 700 to 800 lb/in² (psi). The meter could penetrate no more than 1 inch deep into the soil.

“Within a short period of time after adding the Aqua-PhyD system, compaction was reduced to the 200- to 300-psi range, and the probe penetration increased to 2 ft,” Rai reports.

Rai says the technology improves hydraulic conductivity, increasing water use efficiency. In addition to using less water, the system can help reduce use of irrigation pumps to lower energy costs.
“The Aqua-PhyD unit also improves leaching of salts, which enables the use of water with high levels of total dissolved solids (TDS),” he notes.

For more information, see www.aqua-phyd.com or call 949-476-2782.

—Source: International Agri-Center and Farm Press.

**Precision ag display system**

Trimble recently introduced its latest Global Navigation Satellite System (GNSS) guidance product, the AgGPS FmX integrated display, which it says offers a wide range of precision agriculture applications in a single package. The company says it is the first display system in the industry to work as either a stand-alone manual guidance system or as part of an automated guidance, implement control, or steering system.

Farmers can use the FmX display for a variety of their GNSS control needs including applications that require one or two receivers, such as vehicle guidance, a pull-behind implement, or leveling and drainage equipment. The company says it integrates easily with the Trimble AgGPS Autopilot automated steering system TrueTracker for precision guidance of an implement or with the FieldLevel II system for dual and tandem scraper control. Farmers can also vary crop inputs, control a planter, map fields, and view video camera input of field operations—all with one display.

The FmX touch screen display is 12.1 inches, approximately 35% larger than the industry standard 10.4-inch screen, yet the display requires no more space in the cab than its predecessor, the AgGPS FieldManager display. Crisp graphics and a brighter screen make the FmX easier for the operator to see and interact with the applications being controlled, according to Trimble.

The FmX features two integrated, high-performance GNSS receivers, so no additional receivers are necessary to control a tractor and implement. Optional 450- or 900-MHz radios are also integrated into the display for real-time kinematic (RTK) applications, along with support for up to four external video cameras. Both receivers include GPS and GLONASS (L1/L2/G1/G2) capability, offering a range of accuracy levels up to RTK GLONASS. Trimble says the benefit to farmers is that a larger number of satellite signals can provide more robust positioning, even in difficult GPS or GLONASS environments.

“The FmX will help farmers gain efficiencies across their complete farming cycle,” says Erik Arvesen, Trimble’s general manager of Agriculture. “The integrated components allow farmers to purchase the FmX at a functionality level and price that fits their needs today, with the option to easily upgrade to higher levels of performance as needed. We are packing a lot of capabilities and value into a single package.”

For more information, call 1-800-874-6253 or visit www.trimble.com/precision to find a Trimble reseller.

**Silage bagger**

The Ag-Bag X1114 professional self-propelled bagger by Miller-St. Nazianz, Inc. Company was named one of the top 10 new products at the 2009 World Ag Expo held in February in Tulare, CA. According to the company, the Ag-Bag packs 25% more silage in its 14-ft diameter bag than a conventional 12-ft silage bagger.

“It’s the highest capacity, most productive silage bagger in the history of the industry,” says Taylor Weisensel, the company’s national sales and marketing manager. “It represents the first of the next generation of baggers for forage growers who want high daily production and the ability to store more feed per square foot.”

Compared with a 12-ft bagger, which typically packs forage at the rate of about 2 to 2.25 tons per linear foot on a wet-ton basis, this model can produce densities of as much as 3 tons per linear foot in a bag as long as 500 ft, according to Weisensel. This increased packing density reflects the longer tunnel and the low position of the 11-ft rotor.

“This position packs feed from the bottom to the top, resulting in more uniform packing,” he explains. “In our field trials, operators have bagged silage from well over 350+ acres a day, or 5,000+ tons stored in an average day, depending on field conditions and operator.”

Other enhancements include all-new cab comfort and control upgrades plus improved maneuverability and braking.

For more information, see www.ag-bag.com or call 920-773-2121.

—Source: International Agri-Center and Farm Press.
High fertilizer prices coupled with low commodity prices are causing many grain producers to rethink fertilizer management decisions. The obvious goal is to improve fertilizer use efficiency while maintaining crop productivity. Enhanced efficiency fertilizers are products designed to improve nutrient uptake while stabilized nitrogen products prevent fertilizer N loss. Many producers these days are trying to evaluate the usefulness of several of these products in their cropping systems. High fertilizer prices make these options more attractive because it takes fewer pounds of saved nutrient to offset the additional cost of the new technology.

Currently, there are three types of products being marketed that claim to improve nitrogen use efficiency: nitrification inhibitors, urease inhibitors, and controlled-release fertilizer products. These products work by slowing one of the processes within the nitrogen cycle, thereby reducing N loss. Prior to purchase, producers should have a good understanding of how these products work in order to make informed decisions regarding their use.

**Nitrification inhibitors**

Nitrification is the conversion of ammonium nitrogen (NH$_4^-$-N) to nitrate nitrogen (NO$_3^-$-N) in the soil (Fig. 1). Depending on soil conditions, some inhibitors can slow this process by a few weeks. The most common, nitrapyrin (N-Serve), has been commercially available for 30 years. It can be used with any N fertilizer that contains or produces (when applied to the soil) NH$_4^-$-N. Examples are anhydrous ammonia, urea, and urea ammonium nitrate (UAN) solutions. A new product, Nutrisphere-N (Specially Fertilizer Products, Belton, MO), also claims to prevent nitrification.

Inhibiting nitrification is important because nitrogen in the NH$_4^-$-N form is held tightly by the soil particles and is not subject to leaching or denitrification loss. **Leaching** is when NO$_3^-$-N is moved deeper into the soil profile by moving water. It is possible that soil NO$_3^-$-N can be leached below the rooting zone and then become an environmental concern. **Denitrification** occurs when NO$_3^-$-N is converted into a gas and escapes into the atmosphere. This reaction only happens when soil lacks oxygen or is largely water saturated. Depending on the amount of oxygen in the soil, the gas is emitted either as nitrous oxide or nitrogen gas. Nitrous oxide is a greenhouse gas, and emissions may be regulated in the future. Denitrification losses are most common on poorly drained soils saturated with water during the spring.

**Urease inhibitors**

When urea fertilizers are applied to the soil, an enzyme called urease begins converting urea to ammonia gas. If this conversion takes place below the soil surface, the ammonia is almost instantaneously converted to NH$_4^-$-N, which is bound to soil particles. If the conversion takes place on the soil surface or on surface residues, there is potential for the ammonia gas to escape back into the atmosphere in a process called **ammonia volatilization**.

Volatilization losses depend on environmental conditions at, and subsequent to, the time of application. Soil temperature, soil moisture, amount of surface residue, soil pH, and length of time between application and the first rain event or irrigation are all factors that determine the total amount of N that might be lost via volatilization. Nitrogen losses from fertilizer applied prior to May 1 are generally very low. Potential N loss is greatest after May 1, especially when urea is surface-applied to soils with high residue or vegetation (i.e., no-till corn or pastures) during warm, wet weather followed by a warm, breezy drying period.
Volatilization losses can be substantially reduced if a urease inhibitor is used with the fertilizer. The most common urease inhibitor is NBPT [N-(n-butyl) thiophosphoric triamide], sold under the trade name Agrotain. Urease inhibitors reduce the activity of the urease enzyme for up to 14 days. As long as it rains during this 14-day period, the urea will be moved into the soil where it can be converted to NH$_4$–N without risk of volatilization. Nutrisphere-N also claims to prevent volatilization loss, but research results have been inconsistent.

**Controlled-release urea**

Controlled-release fertilizer products have also been available for more than 30 years. Probably the best known of the older products is sulfur-coated urea. A sulfur coating is applied to urea granules, and urea dissolves/diffuses through imperfections in the coating. By altering the thickness and number of imperfections in the coating, release characteristics can be controlled. Sulfur-coated urea was not a useful agronomic product in part because the cost of coating was high relative to the cost of the N fertilizer.

Recent advancements in polymer (plastic) technology have created a whole new type of controlled-release fertilizer, the most common of which is polymer-coated urea (PCU). Polymer-coated urea has been used in the turf and horticultural industries for several years, but the cost of the materials prohibited their greater use in the agricultural market. Now Agrium Inc. has introduced a PCU called ESN that is priced competitively in the agricultural market.

Modern polymers allow chemists to create release curves that closely match the uptake characteristics of target crops (Fig. 2). The amount and rate of release is controlled by the thickness and other characteristics of the polymer.

**Agronomics of N products**

As alluded to earlier, there are several factors that should be considered before deciding if these products are appropriate and economical in your specific production system.

Ideally, corn producers strive to apply just enough N such that $1 worth of N produces $1 of corn: about 150 lb N/acre (Fig. 3). If a farmer applied the optimal amount of fertilizer and used an inhibitor or PCU, N would be saved, but yield would not be increased enough. In order for these new products to be agronomically useful, the producer must reduce the rate of applied N by the amount of N expected to be saved as a result of using the additive. To be economical, the value of the saved N must exceed the price of the additive.

The second consideration is the time of year fertilizer is being applied. Denitrification occurs primarily when the soil is water saturated. Therefore, losses are usually highest for N applied in the fall or early spring. Later sidedress applications usually result in much less denitrification loss since soil saturation is less likely. The total amount of nitrogen lost as a result of denitrification is a function of the number of days the soil remains saturated and the amount of nitrogen in the NO$_3$–N form (Table 1, next page). Approximately 3 to 4% of the NO$_3$–N can be lost per day of soil saturation beyond two days.

Volatilization losses are highest when the soil is warm (above 50°F), experiencing high evaporation rates, and/or when soil pH is greater than 7. In most years, Kentucky temperatures become high enough to cause concern in early May. After this time, surface-applied urea N is more vulnerable to loss. If the fertilizer is surface-applied and incorporated or a quarter inch or more rain is received within two days, volatilization losses will be minimal. If, on the other hand, it is not incorporated and no rain is received, loss can exceed 25% with an average of about 10% of the total. High surface residue levels also increase volatilization; therefore, maximum losses will...
be observed when urea is broadcast on no-till or pasture fields after May 1.

Polymer-coated urea, because of its slow-release characteristics, offers farmers the option of early fertilizer application with a reduced risk of denitrification or leaching loss. There is still the potential for volatilization losses from this product because it is urea. However, research results demonstrate that the risk of significant volatilization loss from polymer-coated urea is much smaller than for unprotected urea.

**Conclusions**

There are several products that grain farmers can use to help improve fertilizer efficiency. These products are only useful in specific situations, so it is important to understand how they work and when they are most beneficial. It is also important to realize they are designed to conserve fertilizer. Benefits will only be realized if the total application rate is reduced by the amount of fertilizer estimated to be saved by using one of these products.

This paper was originally presented at the 2008 Indiana CCA Conference in Indianapolis, IN in December. Dr. Schwab will be presenting a webinar on this topic on April 1. More information will be emailed to certification holders in March.

**Monsanto closer to providing first drought corn product**

St. Louis, MO–based Monsanto Company has announced a major advancement in delivering the world’s first-ever drought-tolerant corn product to farmers.

On January 7, 2009, in the fourth-annual update of its research-and-development (R&D) pipeline, the company announced that its first-generation drought-tolerant corn has moved to the fourth—and final—phase before an anticipated market launch early next decade. The company also announced that it has submitted the product to the Food and Drug Administration (FDA) for regulatory clearance.

Drought-tolerant corn is designed to provide farmers yield stability during periods when water supply is scarce by mitigating the effects of water stress within a corn plant. Field trials for drought-tolerant corn conducted last year in the western Great Plains have met or exceeded the 6 to 10% target yield enhancement—about 7 to 10 bu/acre—over the average yield of 70 to 130 bu/acre in some of the key drought-prone areas in the United States.

Steve Padgette, biotechnology lead for Monsanto, notes that this is the fastest a product has advanced from one phase into another.

“In the almost 25 years I have been with Monsanto, the advancement of our drought-tolerant corn product into Phase 4 is one of our most significant R&D milestones, making this one of the most exciting times ever for our R&D pipeline,” Padgette said. “We are now intensively selecting the best trait–germplasm combinations to deliver excellent drought-stress performance, and value, to our customers upon launch. This product and other yield improvements we are developing will reset the bar for on-farm productivity.”

**Table 1.** The percentage of fertilizer N in the NO₃⁻N form 0, 3, and 6 weeks after application.

<table>
<thead>
<tr>
<th>N source</th>
<th>% of fertilizer as NO₃⁻N</th>
</tr>
</thead>
<tbody>
<tr>
<td>Anhydrous ammonia (AA)</td>
<td>0  20  65</td>
</tr>
<tr>
<td>AA with N-Serve</td>
<td>0  10  50</td>
</tr>
<tr>
<td>Urea</td>
<td>0  50  75</td>
</tr>
<tr>
<td>Urea with N-Serve</td>
<td>0  30  70</td>
</tr>
<tr>
<td>UAN solutions</td>
<td>25 60 80</td>
</tr>
<tr>
<td>Ammonium nitrate</td>
<td>50 80 90</td>
</tr>
</tbody>
</table>
Monsanto’s corn product represents the first in a series of drought-tolerant and higher-yielding crop technologies that the company is poised to offer farmers over the next decade. Experts have noted that drought-tolerant crop technologies represent one potential tool for ensuring greater sustainability and production within agriculture. Products under development by Monsanto are designed to enable farmers to produce more on each acre of farmland while minimizing the input of energy and resources such as water.

Drought-tolerant corn technology is just one of the products currently under development as part of Monsanto’s R&D and commercialization collaboration in plant biotechnology with Germany-based BASF. The two companies are jointly contributing $1.5 billion over the life of the collaboration, which is aimed at developing higher-yielding crops and crops more tolerant to adverse environmental conditions such as drought.

“This product is the first result of BASF and Monsanto’s plant biotech collaboration. Our joint product pipeline has many high-performing drought tolerant genes, which make us confident that we can live up to our commitment of delivering successive generations of ever more drought-tolerant crops,” says Hans Kast, president and chief executive officer of BASF Plant Science.

Other products in the pipeline

Intrinsic Yield soybeans. BASF and Monsanto are also working together to develop higher-yielding soybean technology, which they refer to as Intrinsic Yield. The product, which promises higher yields through the insertion of a key gene, moved into Phase 3 and will now undergo expanded field trials, regulatory studies, and trait integration into elite soybean germplasm. Once commercially available, the higher-yielding soybeans will build upon the company’s Roundup Ready 2 Yield platform and provide farmers with an additional boost to the incremental yield advantage from that product line.

SmartStax corn. Monsanto says SmartStax contains multiple different modes of action for insect-resistance management, is more effective against above- and below-ground insects, and offers the company’s most comprehensive weed-control system. The product moved to Phase 4, the final step prior to the product’s anticipated 2010 commercial launch. In June 2008, Monsanto submitted a request to the USEPA to set refuge requirements for SmartStax at 5% in the northern Corn Belt and 20% in southern states where cotton is planted, which are lower than those for existing technologies. Monsanto noted that the USEPA has already granted the product’s second-generation YieldGard corn borer technology, which is a key step in the process for receiving approval for SmartStax refuge reduction.

Dicamba- and glufosinate-tolerant cotton. As the first three-way stack of herbicide-tolerant technologies in the pipeline, dicamba-tolerant cotton moved to Phase 2. It adds two new modes of action—dicamba and glufosinate tolerance—to the Roundup Ready Flex system and is expected to provide farmers with the greatest flexibility in weed management and the most effective weed-control system available.

Second-generation, insect-protected Roundup Ready 2 Yield soybeans. This second-generation insect-control product is tailored to South American farmers’ needs and includes an additional mode of action for the reduced refuge requirements. This project is currently in Phase 1.

Roundup Ready, insect-protected sugarcane. Now in the Proof-of-Concept Phase, this Phase 1 project will leverage Monsanto’s recent investment in sugarcane.

In July, Monsanto gained regulatory approvals necessary for the 2009 launch of two biotech crop products. Roundup Ready 2 Yield soybeans received regulatory approval in Mexico, Australia, and New Zealand, adding to the seeds’ prior approvals in the U.S., Canada, Taiwan, Japan, and the Philippines. The company also gained U.S. approval for a biotech trait that protects corn plants from corn borer and other above-the-ground pests. This trait is being offered in seeds, called YieldGard VT Triple PRO, for planting in the U.S. in 2009.

In June 2008, Monsanto announced an ambitious plan to double yields in its three core crops—corn, cotton and soybeans—by 2030 (using 2000 as a base year) as part of a three-point pledge called the Sustainable Yield Initiative. The company says it is also committed to conserving more of the world’s natural resources by reducing by one-third the aggregate amount of key inputs such as water, land, and energy, required to produce each unit. Monsanto plans to do this by providing choices for modern agricultural technology to its stakeholders and has committed to helping resource-poor farm families.
Each year, corn growers apply more than a billion pounds of nitrogen as anhydrous ammonia (NH₃) as crop fertilizer. During the application process, some of the ammonia vaporizes, changing from liquid to gas, which causes application inefficiencies. This article reports recommendations to improve the uniformity of anhydrous application that were the result of a series of field experiments using conventional and nonconventional methods.

Anhydrous ammonia begins as a liquid under its own pressure inside the field nurse tank. The pressure in the tank depends on the temperature of the ammonia. In most applicators, ammonia moves by its own pressure downstream through hoses connecting the tank, regulator, distribution manifold, and subsurface injection knives. Ammonia generally begins to boil as pressure decreases in its travel through the system to the knife outlets, which are at zero back pressure.

To understand the change from liquid to gas, consider ammonia being applied on a warm spring day. Figure 1 shows the relationship between temperature and gauge pressure for anhydrous ammonia when it is at boiling point. The temperature of the ammonia inside the tank may be 70°F. Ammonia at 70°F inside the tank creates a tank pressure of 114 lb/in² (psi). When the exit valve is opened, ammonia leaves the tank through the valve, supply hose, and quick-release coupler, with the pressure dropping along the way due to friction. As the pressure of the ammonia drops, some of the ammonia boils, creating ammonia gas. The energy required to change this ammonia from a liquid to a gas is derived mainly from the ammonia itself, which cools the flowing mixture of gas and liquid.

The variable orifice used to restrict and meter flow inside the regulator further reduces pressure. In the example above, pressure inside the distribution manifold may fall to 34 psi, and the ammonia may cool to about 20°F. At this point, about 10% of the ammonia mass has changed from a liquid to a gas. But because ammonia gas at this temperature and pressure takes up about 240 times more volume than an equal weight of liquid, most of the volume in the line is gas.
This can make uniform division of ammonia flow within the manifold quite difficult, with just a trickle of liquid in the line representing 90% of total ammonia by mass that is to be equally divided among outlet ports.

**Methods to increase flow uniformity from manifold outlet ports**

Equipment operators can use several techniques to obtain more uniform ammonia flow from the manifold outlet distribution ports. Equal hose length between the manifold and each knife helps ensure an equal friction loss through each hose to the knife. Experiments at Kansas State University indicate a flow reduction of as much as 10% when the length of some outlet hoses is doubled from 7 to 14 ft. In general, flow changes about 1 to 2% per foot of hose length. The tests further indicate that if manifold pressure is increased by using flow restrictors on outlet hose barbs, differences from hose length are even less. Hoses to knives near the manifold usually must be coiled if equal hose length is used. Keeping coils in a horizontal plane with ties or other supports prevents liquid ammonia from pooling in the lower parts of the hose coils and affecting uniformity.

Unused manifold outlets should be plugged evenly around the perimeter so that ammonia leaving the manifold has an equal opportunity to depart. Figure 2 is an example of the ammonia-nitrogen application rates for each of the 11 outlet ports of a manifold. Tests at Iowa State University show that ammonia flow from the port with the greatest output is commonly two to three times greater than that which is flowing from the port with the least output—even with equal hose lengths, horizontal hose coiling, and unused outlets plugged at uniform spacing around the manifold perimeter.

Tests indicate that outlet ports in different regions of the manifold may have higher or lower flow rates depending on their position relative to incoming ammonia. Imagine a clock face around the manifold and that flow enters a 90° pipe elbow from the bottom of the picture (at the 6 o’clock position). Although flow is turned 90° into the manifold center, momentum carrying the liquid around the outside of the pipe-elbow curve may be responsible for outlet ports across from the incoming flow (in the 10 o’clock to 2 o’clock positions) receiving greater amounts of ammonia outflow. Ports behind the incoming flow (in the 4 o’clock to 8 o’clock positions) tend to receive intermediate amounts of flow. Ports midway between these regions (from 2 o’clock to 4 o’clock and 8 o’clock to 10 o’clock) receive the least amounts of flow.

In an experiment to further test this theory, plugging adjacent manifold outlet ports across from the entry (10 o’clock to 2 o’clock) resulted in a distribution as uniform as plugging ports evenly spaced around the manifold perimeter. Thus, without additional knowledge, evenly spacing plugged outlets around the manifold perimeter is desirable; however, knowing relative flow amounts received by different manifold regions may allow certain unbalanced plugging schemes without detrimental effects.

These tests suggest that knives across the back of the application toolbar should not be connected in sequential order to outlet ports around the manifold perimeter. Instead, hoses to adjacent knives should be attached to different regions of the manifold so that two low-output or two high-output ports are not paired.

A heat-exchanger (“cold-flow”) flow controller helps obtain the correct overall application rate per acre by measuring total system flow. Although a small portion of total flow is sacrificed to evaporation, incoming flow may be cooled to near 100% liquid and total flow accurately measured. Such systems help to accurately control overall application on a per-acre basis; however, gas forms once flow is regulated downstream through a pressure-reducing valve, resulting in a similar distribution problem.

---

1 At atmospheric pressure (i.e., zero gauge pressure) beyond the knife outlet, liquid ammonia expands about 800 times as it transforms to gas.
for the manifold to that of a conventional regulator. In addition, the sacrificed vapor (gas) flow often is indiscriminately applied to one or more knives and may cause further variation across the width of the applicator.

Other manifold styles

The Vertical Dam manifold (distributed by Continental NH3 Products, Dallas, TX) attempts to separate liquid and gaseous ammonia by tangentially inputting flow into the manifold housing. Centrifugal force separates the more dense liquid on a path near the housing’s inside wall from the less dense gas toward the center. The action is similar to a cyclone dust collector on a grain mill that separates dust from air. Field distribution tests at Iowa State University indicate that a Vertical Dam manifold sized for low flow rates provides more uniform distribution at lower application rates (50 or 75 lb N/acre) than does a conventional manifold. At higher application rates (150 lb N/acre) with a standard configuration for corn (SVD-01 housing; corn: 30 inches = 75 lb N min/acre ring), distribution is at least as uniform as with a conventional manifold.

Using an R-152 (cotton) ring with the SVD-01 housing typically improves distribution at 150 lb N/acre compared with the corn ring. Smaller orifices inside the R-152 distribution ring increase manifold pressure. Producers who apply no more than 125 to 150 lb N/acre may want to try the smaller ring size for improved uniformity if manifold pressure is monitored. Manifold pressure greater than about 65% of tank pressure indicates that total application may be restricted and a ring with larger orifices should be used.

Summary

A small percentage of ammonia vaporizes when ammonia moves downstream through an applicator and pressure drops. Although most of the mass of ammonia in the applicator is still liquid, gaseous ammonia becomes a large part of the total volume inside the hoses and valves. After ammonia has passed through a metering valve, more than 90% of the space inside the manifold distributor is filled with ammonia gas. This makes it difficult to obtain uniform distribution through manifold outlet ports.

Using equal-length hoses between each manifold outlet port and knife, coiling hoses horizontally to knives adjacent to the manifold, and plugging unused outlet ports at even spaces around the manifold perimeter are helpful, but not a panacea. Tests indicate that doubling the hose length from 7 to 14 ft results in only a 10% decrease in ammonia flow, whereas flow extremes from different outlet ports may vary by 200 to 300%.

Because of a tendency for ports in different parts of a manifold to have variable flow rates, it is recommended that ports around the manifold perimeter not be connected sequentially to the knives. That is, adjacent knives on the applicator should not be connected to adjacent outlet ports on the manifold. At application rates of 50 to 75 lb N/acre (or for higher application rates with a properly sized outlet ring), a Vertical Dam manifold generally has better distribution than a conventional manifold. Newer, nonconventional manifolds soon may be marketed, and some of those tested at Iowa State University may have increased uniformity. Before purchasing a new manifold that advocates greater application accuracy, ask the manufacturer for test data to support the claims.

Reprinted with permission from Iowa State University Extension. See www.extension.iastate.edu/Publications/PM1875.pdf

References

Soil Science
Step-by-Step Field Analysis

Sally Logsdon, Dave Clay, Demie Moore, Teferi Tsegaye, editors

Natural resource manager, agronomist, land use consultant, educator, environmental consultant.... The lines are blurred, the questions are complicated, and soil science is required knowledge. Soil Science: Step-by-Step Field Analysis provides the knowledge for conducting specific activities related to improved natural resource management. Readers will learn both new procedures and tips for improved performance in the field, with a focus on usefulness for real-life applications.

Learning objectives:
• safety protocols for soil sampling
• soil profile description
• reducing sampling error for samples sent to a lab
• understanding variability of soil properties—pH, electrical conductivity, nutrient levels, and salinity—and how they affect crop growth
• site evaluation for specific end uses
• installing wells and piezometers, monitoring water table information
• surveying using simple or sophisticated equipment
• cleaning yield monitor data
• evaluation of overall soil quality
• identification of water repellency
• measuring soil density and water content, infiltration, temperature, and rainfall rate

2008, 255 pages
Water-resistant softcover, coil binding, 8 1/2 by 11”
Soil Science Society of America
ISBN: 978-089118-849-0

Order Today
Item number: B60915
$75.00 (Member Price: $60.00)

Online: www.societystore.org
Phone: 608-268-4960
Fax: 608-273-2021
Email: books@agronomy.org

Soil Science Society of America
677 S. Segoe Rd. • Madison, WI 53711
TEL: 608-273-8080 • FAX: 608-273-2021
www.soils.org
Stevens Hydra Probe Soil Sensor
turn your data into growth

All in one multi-parameter soil sensor
The Stevens Hydra Probe soil sensor is the most robust and unique soil sensor available. Users can select up to 22 parameters, including:

- Soil Moisture
- Soil Temperature
- Soil Electrical Conductivity
- Real and Imaginary Dielectric Permittivity
- and many more!

Features of the Stevens Hydra Probe
- Extensively researched and well-tested, durable design provides quality data over many years without removal or recalibration
- Over 10 years of field use
- Excellent precision and accuracy
- Temperature corrected measurements
- Smart Sensor technology
- No calibration required for most soils
- SDI-12 or RS-485 signal output

Over 100 universities, government agencies (USDA, USGS, NOAA, DOD, NASA), farms, vineyards and other companies use the Hydra Probe for quality data analysis!

The POGO portable multi-parameter soil sensor - just poke and go!
The POGO portable soil sensor enables manual readings to be taken quickly and easily. Simply insert the Hydra Probe into the soil you wish to sample, select the soil type and user defined location, and click “Sample” on the PDA’s screen. The soil measurements can be logged to the PDA for further analysis via MS Excel or other spreadsheet programs.

The POGO enables immediate understanding of soil conditions for agriculture, greenhouse monitoring, research, golf course greens, ground penetrating radar studies or any other application that requires manual checking of soil conditions at multiple locations.

Data Loggers
Tel: 800.452.5272
503.445.8000
Web: www.stevenswater.com/csa

Water Level & Quality

Radio Telemetry

Weather Sensors

Monitoring the Earth’s Water Resources Since 1911

Stevens Water Monitoring Systems, Inc.