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

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CARBON CREDITS FOR MANAGING CROP NUTRIENTS

"Farmers have real, measurable, additional carbon credits to offer world markets."
(Don McCabe, Ontario Federation of Agriculture)

Agricultural organizations have been seeking opportunities for recognition of farmer contributions toward mitigating greenhouse gases. For this to happen, regulatory programs need to allow offsets. Offsets are defined as carbon emission reduction credits traded from regulated to non-regulated industries. Governments plan to regulate greenhouse gas emissions from large factories, but not those from farms. Farm emissions are diffuse, sporadic, and difficult to measure directly. Nonetheless, science is elucidating the effects of crop management practices in terms of probability and magnitude of mitigation, and this provides a potential opportunity for farmers to receive carbon credits.

A common first reaction to the concept of carbon credits is: "I don't like the idea of letting large companies off the hook by paying for the right to pollute!" In an ideal world, no one would be allowed to pollute. But in reality all human activity has impacts on the environment. Even breathing emits carbon dioxide. The concept of carbon trading recognizes this, and facilitates cost-effective reductions. It also opens big opportunities for collateral improvements benefitting crop production.

Storing carbon in the soil doesn't just reduce the carbon dioxide in the air; it's good for the soil. Farmers have long been encouraged to build up soil organic matter, for its contributions to soil structure, soil nutrient retention, and prevention of erosion – long-term benefits that often don't relate directly to short-term profit. Carbon trading provides funds to strengthen the short-term incentives to help get to the long-term benefits.

So, working with the carbon trading programs that are developing is a good idea. It's also an important opportunity for crop advisers to contribute their expertise to make sure it's done right. There are pitfalls to such programs. Here's what to watch out for.

First, many programs looking at specific emissions in isolation lose sight of the whole picture. For example, carbon credits are often calculated on a per-acre basis for implementing specific practices that are thought to increase soil carbon or reduce losses of N. If the effect of the practice on the yield or quality of the crop is not taken into account, the net greenhouse gas emission per unit of production may actually go in the opposite direction, or be smaller than that calculated per unit of land area. If society's demands for production from the whole system are to be met, the increased land requirement may negate all benefits of the practice.

Second, practices are site-specific in their impacts on yields, greenhouse gas emissions, and the total performance of the cropping system. It takes a person with agronomic expertise to advise on the selection of the right practices to reduce the carbon footprint of a unit of crop produced.

Sound agronomic recommendations contribute to higher crop yields that increase the return of carbon to the soil, and conserve soil organic matter with the appropriate tillage management. They include recommendations for the right source, rate, timing and placement of plant nutrients. The right combinations can increase N use efficiency and minimize nitrous oxide emissions.

For many situations, investments in science are needed to develop practices to achieve these objectives. The fertilizer industry is supporting a right source – right rate – right time – right place nutrient stewardship strategy that emphasizes the development of science-based practices leading to a more economically, environmentally and socially sustainable agriculture. Let's take advantage of the opportunity carbon credits provide to make progress on this strategy.

—TWB—

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Abbreviations in this article: N = nitrogen.

Note: ***Plant Nutrition TODAY*** articles are available online at the IPNI website: www.ipni.net/pnt

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DOING A GOOD JOB OF SUPPLYING SOME NUTRIENTS? DON'T FORGET TO MONITOR OTHER NUTRIENTS

One characteristic of a successful cropping program is that plant essential nutrients are absorbed at adequate amounts so that crop yields are not limited by any nutrient deficiency. In much of the former grasslands of the Northern Great Plains (NGP), the fertility level of the original soils was relatively high. Much of the land was converted from natural grasslands to annual cultivated crop production in the late 1800s to the early 1900s. This means that the land has now been cropped for about 100 years or more. Most of the early crops grew well and the only yield limitation was usually a result of a lack of adequate moisture in a year of low rainfall. However, after a decade or two of cropping, yields were observed to decrease even during years of adequate moisture. Through trials, it was found that if a N-fixing legume crop such as sweet clover was grown as a green manure crop and plowed down, the subsequent crop yielded well. This showed that the first nutrient to become yield limiting was N. Phosphorus was the next nutrient to limit yields. Inadequate availability of these two nutrients is common because crops take them up in relatively large amounts and the majority of what is taken up is removed in the harvested portion of small grain cereal and oil seed crops.

Most of the fertilizer programs used in the NGP are dominated by N and P applications. By adding adequate N and P, production has been sustained for decades. But other crop nutrients have been removed steadily, even though in many instances in small amounts. Many soils can supply adequate amounts of many of the other plant essential nutrients for decades if not centuries. However, specific nutrients decrease in availability sooner for certain crops on specific soils. Often, the higher the level of production that is targeted and attained using high rates of N and P the sooner other nutrients can become yield limiting.

One example is high yielding barley silage production in central Alberta. Much of the land used for barley silage production is near cattle feedlot operations and the manure from the feedlot is applied back onto the land that the silage came from. It was thought that the manure applications would sustain yields, but barley yields began to decline. They even seemed to become worse when higher than normal N fertilizer rates were applied. Along with low yields, the barley was observed to have weak straw prone to lodging, a large proportion of sterile florets resulting in poorly filled heads and shriveled kernels resulting in low bushel weights. Initial observations indicated that the crops were deficient in copper (Cu). This was surprising because prior to the mid 1980s, agronomists in Alberta thought Cu deficiencies were limited to some deep organic soils (>18 in. or 45 cm.) and Cu deficiency did not affect crops growing on mineral soils (Alberta Agriculture and Rural Development). However, field research confirmed that there were definite Cu deficiencies when plant available copper was less than 0.4 ppm DTPA extractable. The application of manure was useful for maintaining or even increasing levels of organic matter, but the increased organic matter was found to tie up plant available Cu. Fortunately the addition of adequate rates of soluble Cu fertilizers can correct Cu deficiencies.

Another example is sulfur (S) deficiencies for canola or other high S requiring crops. Deficiencies of S tend to develop sooner on coarse textured or sandy soils that are low in soil organic matter and under higher rainfall areas. In some cases low canola yields can be caused to decrease even more when N fertilizer rates are increased without adding any S fertilizer. This is attributed to the need to balance N with an adequate amount of S. For example, canola requires a lower N to S ratio than cereal crops, respectively 7:1, compared to 10:1.

It is important to monitor other plant nutrients besides N and P on a regular basis. This can be done by regularly taking soil samples and having the soils tested for all potentially deficient macro and micro nutrients for your area. The soil sampling should be supplemented with plant analysis results from growing crops to confirm if low soil test levels result in sub-optimal plant test levels. It is economically beneficial to notice a developing nutrient deficiency before it becomes severely yield limiting and correct the deficiency using fertilizer applications.

—TLJ—

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Abbreviations in this article: N = nitrogen; P = phosphorus; ppm = parts per million.

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UNIFORM IRRIGATION IS KEY TO FERTIGATION

A crucial requirement for effective fertilizer injection into irrigation water is system uniformity. Nutrients applied through the irrigation system cannot be delivered to the crop in the right amount unless the water delivery is uniform across the field.

Both excessive and under-irrigation can reduce crop yield and quality. A mere 10% change above or below the optimal water supply can impact the yield of many crops. Over irrigation can reduce plant growth by causing poor soil aeration, increasing root diseases, and leaching nutrients from the root zone. A lack of water increases plant stress, limits photosynthesis, and stunts cell development. While meeting the "average" crop water need is important, uniform application of water over the field is equally important. If using a non-uniform irrigation system, too much water and fertilizer will be applied in one area, and short-changed in another.

Using a drip irrigation system as an example, an application that is 100% uniform would deliver exactly the same amount of water from every emitter each hour. If there is variability between the emitters, the amount of water and applied nutrient can vary widely for each plant in the field. Physical, chemical, and biological plugging and uneven water pressure can cause increased variability in water delivery for micro-irrigation systems.

Having an irrigation system with a high uniformity leads to higher crop yields and profitability. Well designed and maintained center-pivot and linear-move irrigation systems are capable of attaining uniformity coefficients of 90 to 95%. Common problems causing water to be poorly distributed include worn nozzles, improper pump pressure, misaligned heads, and windy conditions during irrigation.

Surface irrigation can also deliver water very uniformly under ideal conditions and management. Irrigation uniformity using surface irrigation techniques is highly dependent on the water infiltration rate and other soil properties.

In addition to a uniform irrigation system, also take care to inject the fertilizer so that it is distributed through the entire field. The injected nutrients do not immediately start coming out of the irrigation system. It takes time for the water and fertilizer to travel through the irrigation system plumbing. Do not inject the fertilizer and then quickly shut down the irrigation system. Always run clean water after adding fertilizer.

Mixing soluble fertilizer with the irrigation water can be an excellent method of delivering nutrients to crops. There are many outstanding sources of nutrients that are compatible with various irrigation systems. Remember to pay attention to the entire system to get the most value from your irrigation water and added nutrients.

—RLM—

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ESTIMATING YIELD LOSS FOR FERTILIZER RATE REDUCTIONS

A common question asked in unfavorable economic times is: "How much yield loss can I expect if I cut my nutrient rates?" While the inquiry appears simple, answering it is not. Generally, when farmers ask this question, they have too little money available to afford the entire quantity of nutrients being recommended. When governments and industries ask this question, they generally have insufficient supplies of nutrients to meet all the needs of the crops in their regions.

Whether or not measurable yield losses will occur when rates are reduced depends primarily on the quantities of nutrients already available in the soil. The higher the quantity of available soil nutrients, the less responsive crops become to nutrient additions. When no fertilizer is applied, soils that have greater quantities of nutrients will produce yields higher than those with lower levels. This general principle operates regardless of the nutrient.

Another consideration is the philosophy used by the adviser making the nutrient recommendation. Using rates that maximize economic returns to nutrients in one season is not always the objective. There may be other factors, such as addressing the uncertainty in characterizing the nutrient supply of the soil, that are more important. Farmers who want to ensure nutrients are non-limiting often apply rates that exceed those necessary for maximizing short-term economic returns with the objective of maximizing long-term returns. In such cases, cutbacks in application rates may cause no measurable reductions in yield in the short term. The impacts come later. Relying more on the soil resource today means that in the future, soil resources won't be as large and dependence on supplemental nutrients will increase.

A fundamental problem in estimating yield loss is that the yield response to nutrients as well as the soil nutrient supply are often poorly characterized. Just how much an area of the field will yield in a particular year if left unfertilized and how much yield is gained from a nutrient addition are usually not known.

Although limited in scope, it is possible, with many assumptions, to reasonably estimate some amount of yield loss when rates are cut back from those that are economically optimum in the short term. A simple spreadsheet was developed to help farmers and advisers do some general estimates. The spreadsheet is available in the Toolbox section of IPNI's website: >**www.ipni.net/toolbox**<.

—TSM—

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FERTILIZING COTTON THE "RIGHT" WAY

The way fertilizers are managed for cotton production can have a major impact on the efficiency of nutrient use by the crop and the potential impact on the surrounding environment. Growers are continually striving to implement fertilizer best management practices (BMPs) on their farms to improve nutrient use efficiency. By increasing the pounds of lint produced per acre for each unit of nutrient applied, growers can benefit not only from greater productivity and profitability, but also from the positive influence their practices have on cropping system sustainability and environmental health. The underlying principle for fertilizer BMPs can be described as the "Four Rights (4Rs)" strategy… applying the right nutrient source at the right rate, at the right time, and in the right place.

The "Right Source" for cotton production in the South is one that is appropriate for the soil and cropping system conditions. For example, when incorporation of surface-applied urea is not an option, selecting a less volatile N source like ammonium nitrate can help minimize losses and improve fertilizer use efficiency. It is also prudent to select fertilizer sources that supply nutrients in the appropriate relative amounts as determined by a soil test or plant tissue analysis.

The "Right Rate" can be determined using a variety of methods. The main science-based tool used to estimate the nutrient requirement for cotton production is soil testing. Regular soil testing of all the fields on a farm acts as an excellent gauge of nutrient sustainability. Other methods used to determine fertilizer application rates in the South include nutrient budgets, expected yield goals, and tissue testing.

The "Right Time" to apply fertilizer to a cotton crop is prior to the point of maximum uptake rate. Research in the South has generally shown that when all the N is applied preplant for non-irrigated cotton, yield is optimized. However in irrigated environments, cotton yields and uptake efficiency are often improved with split applications: one-fourth to one-half preplant with the remainder applied before flowering. This application scheduling follows the uptake pattern more closely, with the bulk of the N requirement being applied at the time when plant demand and uptake rate are highest.

The "Right Place" for fertilizer application is one that provides rapid uptake by the crop and reduces potential losses. The mobility of a nutrient in the soil plays a large role in the importance of placement. Immobile nutrients, such as P and K, are taken up from an area right around the root surface. This is why localized placement or banding of these nutrients is often beneficial. However, research with cotton showed that placement of P becomes less critical as soil test P increases from low to high levels.

Paying attention to the 4Rs and recognizing their interaction and interdependence when making fertilizer decisions can lead to greater production system success. Determining what is "right", however, depends on many site-specific factors including soil, climate, and management system. To learn more, check out the 8-page publication titled *Apply the "Four Rights" for Cotton Production in the Midsouth and Southeast*. It is available as a PDF file with a companion PowerPoint slide set at the IPNI website: >**www.ipni.net/bmp**<.

—SBP—

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

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NUTRIENT CRITERIA, STANDARDS, AND TMDLS— WHAT ARE THEY AND WHY SHOULD WE CARE?

Much progress has been made in the USA in the last several decades in protecting and improving water quality. Yet, in some areas of the country there are still a number of water bodies with impairments associated with nutrients: N and P. The most recent national assessment of water quality found that nutrients ranked second as the cause of impairment in lakes, reservoirs, and ponds, and third as the cause of impairment of rivers and streams. Nutrients ranked ninth as the cause of impairment in estuaries and bays and eighth in oceans and near coastal waters.

When N and/or P move from farm fields to streams, rivers, lakes, and other water resources in concentrations higher than normal levels (i.e above current "background" or natural levels), they are considered pollutants. Excessive loads of N and/or P in surface water resources can lead to increased algae growth. Increased growth of algae may increase turbidity or reduce clarity, reduce concentrations of dissolved oxygen, and possibly result in harmful effects on invertebrate populations and the health of higher organisms like fish. We all have heard or read about fish kills that resulted from depleted oxygen levels in aquatic systems, which may have been associated with excessive nutrient loads.

Virtually all of us live "downstream" from someone else. Those who live the farthest downstream may be particularly interested in the good land and water stewardship practices implemented by their upstream friends and neighbors in efforts to protect and preserve water quality.

The U.S. Environmental Protection Agency and its partnering state and tribal water quality agencies are responsible for ensuring that water resources are safe and meeting the quality necessary for their designated uses, which may include domestic consumption. State water quality authorities are responsible for monitoring water quality and for developing nutrient criteria. The nutrient criteria may be used to set water quality standards for protection and preservation of designated water uses. If a waterbody fails to meet established standards and is deemed impaired, it may be subjected to Total Maximum Daily Load (TMDL) regulation. A TMDL is a scientific determination of the maximum amount of a given pollutant that surface water can absorb and still meet the water quality standards that protect human health and aquatic life. Regulation of nutrient discharges can be costly and onerous to many watershed stakeholders. Increasingly, agricultural stakeholders are being blamed as dominant nonpoint source (diffuse) nutrient polluters.

An important and meaningful goal for agricultural producers in 2009 –both crop and livestock – would be to strive to improve or protect water quality in one's local watershed through implementation of more fertilizer and manure best management practices (BMPs). Keeping more nutrients in fields and out of water resources enhances crop and livestock nutrient use efficiency and effectiveness, stimulates agronomic performance, prevents loss of valuable inputs, and demonstrates good land and water stewardship...to your family, friends, and neighbors.

Look for opportunities to improve agronomic nutrient management, for the local good...and that of our neighbors downstream…today and into the future. Let's strive for a legacy of nutrient stewardship and water quality protection we can all be proud of.

—CSS—

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FERTILIZER INPUTS FOR TURF

Turfgrasses have many benefits that can be separated into: 1) functional, 2) aesthetic, and 3) recreational components. Among the functional benefits are soil erosion control, dust stabilization, enhanced groundwater recharge and surface water quality, heat dissipation and temperature moderation, sequestration of CO_2, and several others. Aesthetic benefits of lawns and other turfgrass areas result in a positive therapeutic impact that improves mental health and productivity, contributes to social harmony and stability, and generally improves quality of life, especially in densely populated areas. Turfgrasses also provide a relatively low-cost, safe recreational surface that reduces injuries when compared to non-turf areas. Additionally, the upkeep and maintenance of home lawns provide exercise and a diversion beneficial to mental health. Considering the general benefits of turfgrass, it is apparent that the preservation and maintenance of these areas, including home lawns, is an important objective.

A good fertility program is among the most important factors affecting turf quality. Proper fertilization is often the most cost-effective means of achieving attractive and functional turf. It involves applying the appropriate type and amount of fertilizer at the right time, and must be combined with proper mowing, watering, and pest management for the best results.

Each nutrient plays a specific role in turfgrass growth, development, and reaction to stresses from diseases and other pests. Consequently, specific responses to needed fertilizer application are commonly observed. For example, turfgrass response to N fertilizer is very common and is usually expressed in improved color (darker green, more chlorophyll), density, root growth, stress tolerance, and recuperative potential. Turfgrass response to P fertilizer is often expressed as in improved root growth and branching, drought tolerance, water use efficiency, and seedling establishment. Adequate K fertility is associated with increased disease resistance, increased cold and heat tolerance, and improved overall ability to endure and recover from stressful conditions. Although these nutrient response comments are general and limited, they illustrate that proper nutrition can greatly impact turf quality and performance. It should also be noted that over-fertilization is possible and can have undesirable consequences to turf and the environment.

Among the factors that affect best fertilizer management practices for turf are:

- **Objectives and purpose of the turf area.** The more intensive the use the more intensive will be the management requirements.
- **Grass species.** The turfgrass species that is most appropriate will be determined mainly by the location. Nutrient requirements vary widely among turf species.
- **Soil environment.** Sandy soils are usually more infertile and require more intensive nutrient management than loamy or clayey soils. Soil testing should be used to help guide turf fertilization decisions.
- **Water and irrigation, clipping management, lawn age, and shade are also considerations in determining the need for fertilizer inputs.**

Some municipalities have taken a minimalistic approach to urban turf fertilization by implementing serious restrictions and even all-out bands on the use of P fertilizers on turf in an attempt to reduce nutrient runoff. Ironically, in some cases this can have the opposite of the intended effect. Turf health can be diminished by input reduction, sometimes resulting in an increase rather than a reduction in runoff losses.

Complete and balanced fertilization of turfgrass is important in maintaining the functional, aesthetic, and recreational value of turf. IPNI has recently released a new publication on turf fertilization and BMPs. The publication is available for viewing at the BMP section of the IPNI website: >**www.ipni.net/bmp**<.

—WMS—

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Abbreviations in this article: CO_2 =carbon dioxide; N = nitrogen; P = phosphorus; K = potassium.