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

From Scientific Staff of the
International Plant Nutrition Institute (IPNI)
3500 Parkway Lane, Suite 550
Peachtree Corners, Georgia 30092-2844 USA
Phone: 770-447-0335 Fax: 770-448-0439
E-mail: info@ipni.net Website: www.ipni.net

Winter 2014/15, No. 1

SUSTAINABILITY, STEWARDSHIP, AND THE NUTRIENT MANAGEMENT PLAN

Demand for sustainability information is building. According to Canada's Provision Coalition, today's sustainability-conscious consumers want to know the whole story—cradle to grave—behind their food purchases. How can nutrient stewardship—the responsible management of crop nutrition—be communicated in a manner that builds the public's trust?

Nutrient management plans track a lot of detail essential for the farm manager. Plans that track the source, rate, time and place of every nutrient application help crop producers and their advisers as they seek to improve the sustainability of their crop nutrition management. They are inadequate, however, for communication to all the stakeholders of the agricultural system, since they do not condense and interpret the vast volume of information they generate. They don't mean a lot to those not fully familiar with the specific soils, cropping systems, weather and climate of a specific farm in a specific region.

A plan needs to fit into a reporting system. For crop producers to be recognized as contributing to sustainability, their management plans need to fit into sustainability reporting systems that address the key questions being raised. Such reporting needs to distill the detail of nutrient management plans into simple reportable metrics that are meaningful to the people who eat the food and use the products of the farming system, and who drink the water and breathe the air it impacts.

A plan considers all four Rs. Sustainable crop nutrition demands use of the "right" combination of source, rate, time and place for each nutrient application. The "right" combination is the one that makes progress on three key areas controlled by management of crop nutrition: supporting productive crops, keeping soils fertile, and improving nutrient use efficiency. Nutrient use efficiency on its own is not enough. Fertilizer source, timing and placement can dramatically impact air and water quality even in situations where their effect on nutrient use efficiency is small. All key areas need to be reflected in the metrics that are chosen.

Adoption of nutrient management planning has been limited. Nutrient management plans for livestock operations have focused on managing nutrient surpluses associated with manure and monitoring regulatory compliance. In many regions, excellent software tools have been developed for such plans. In general they track the source, rate, time and place of all nutrient applications made on the farm. The plans, supported by software, have become useful for education, management, and record-keeping. Yet relatively few growers, particularly among cash crop operations, have adopted them. Also, even where they have been adopted, they are not always referred to or followed.

To gain greater adoption of nutrient management planning, what needs to change? The 4R Nutrient Stewardship framework offers up some ideas. A 4R plan has a purpose that benefits the farm. The plan is part of a strategy to highlight the farm's progress toward enhanced sustainability. It reports on metrics of key importance, related to the farm's sustainability goals. The goals relate to economic, environmental and social impacts of the operation, the key current concerns of the farm's regional stakeholders. Reporting these metrics to an aggregator for the industry supports a communications program that can contribute to building public trust and improving the business climate for farming.

Efforts are currently underway to raise the profile of 4R Nutrient Stewardship. These efforts across North America include gaining the support of many stakeholder organizations, including industry, government, research, extension, and environmental groups. Whether you are a crop producer or a crop adviser, now is the time to become familiar with the benefits and requirements associated with 4R Nutrient Stewardship planning.

– TWB –

For more information, contact Dr. Tom Bruulsema, IPNI Director, North American Program, Ph: 519-835-2498; E-mail: tom.bruulsema@ipni.net.

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

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RIGHT RATE, ESSENTIAL IN 4R NUTRIENT STEWARDSHIP

The 4R Nutrient Stewardship principles are defined as using the right source of fertilizer at the right rate, time, and place. All four of the Rs are combined, and important, when nutrients are applied as fertilizer on a farm field. However, **Right Rate**, is especially critical for the full benefit of a fertilizer application. Rate is a threshold requirement, where if the threshold rate is not reached, other 4R factors of source, time and place will not be able to compensate.

Most crops have a concentration range for each required nutrient, and if a specific nutrient concentration within the plant is within that range there shouldn't be any growth or yield limitation observed. However if the nutrient concentration is too low in the crop plant tissues, nutrient deficiency symptoms and decreased yields can result. For example the chart below shows the nutrient sufficiency range for seedling corn.

Nutrient	Nitrogen (N)	Phosphorus (P)	Potassium (K)	Sulfur (S)
Sufficiency Range	3.5 - 5.0	0.35 - 0.80	3.3 - 5.0	0.2 - 0.5

Source: http://www.agvise.com/wp-content/uploads/2012/09/Interpreting-Plant-Analysis-Reports.pdf

Too low of a rate is often the cause of a specific fertilizer application combination being less effective. A useful example is a field research project I was involved in on a ranch near Invermere, BC. The ranch owner mentioned to his local fertilizer retail dealer that he thought from visual observation the annual fertilizer applied on a mixed alfalfa-grass hay field (25% alfalfa and 75% forage grass) wasn't very effective. The regular early spring broadcast application was a 40 lb N, 30 lb P_2O_5, 40 lb K_2O, and 15 lb S/A. After conducting a small plot research experiment it was determined that the rate of nitrogen was too low to maximize forage growth and yield, and effectively utilize the other nutrients being added. It was recommended to increase nitrogen applications up to 70 lb N/A and keep the other nutrient application rates the same. Too low of a nitrogen rate was limiting crop response, even though the forms, timing and placement of fertilizer was appropriate.

The effect of using too low of a rate on crop yields can be delayed, and by the time it is observed there may have already been considerable economic loss. This is especially true for phosphorus and potassium fertilization, as both of these nutrients are best managed in the longer-term by maintaining plant available levels where crop yield is optimized. In contrast, reducing nitrogen rates excessively on a cereal crop will usually result in severe yield loss within one year. Suboptimal rates of phosphorus and potassium, less than crop removal, result in a gradual draw down of plant available soil levels. Reducing nutrient application rates below crop needs will eventually cause crop yields to decline**.**

Determining the Right Rate of various nutrients to be applied is vitally important to the success of a nutrient management program. I'm not suggesting that you can forget about applying an effective form of fertilizer, or not applying the fertilizer at the appropriate time or placement to get the needed nutrients to a crop. But too low of a rate can result in a low yielding crop even if all other crop fertilizer and agronomic practices are properly conducted.

– TLJ –

For more information, contact Dr. Thomas Jensen, IPNI Director, North American Program, Ph: 306-652-3535; E-mail: tjensen@ipni.net.

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ANOTHER LOOK AT LIMING ACID SOILS

It is estimated that soil in over 30% of the world's cropland is acidic and would benefit from liming and soil improvement. Most soils have a natural tendency to become acidic over time through natural and managed factors. Farmers too often fail to monitor soil acidity, despite its widespread nature.

Several natural factors contribute to the development of soil acidity. The geologic material that weathers into soil has a large influence on soil pH. Acid soils occur more frequently in high rainfall areas where leaching removes cations such as calcium and magnesium from the root zone. Poor plant nutrition is frequently a significant problem in acid soils due to the lack of adequate calcium. Phosphorus availability also becomes limited as the soil pH drops. Soil acidity also limits nitrogen fixation in many legume crops. However, aluminum toxicity is usually the largest constraint to plant growth in acid soils.

Nitrogen fertilizer can also be a contributor to the development of soil acidity. When urea or ammonium-based fertilizers are converted to nitrate by soil bacteria, hydrogen ions (acidity) are naturally released. Any nitrogen source containing ammonium (including manures, composts, or cover crops) will contribute to the gradual process of acidification.

There are many examples to show where decades of repeated nitrogen fertilizer use has led to a gradual decline in soil pH. This gradual soil acidification can occur even in regions where acidity problems are not common. For example, this natural process is often noted in areas where nitrogen fertilizer is repeatedly applied to the same place in the soil for many years, such as surrounding a drip irrigation emitter in a permanent crop. Fortunately, measuring soil pH is one of the easiest analyses to perform in the laboratory.

The addition of ground limestone to agricultural soils neutralizes acidity and reduces the presence of soluble aluminum, which is toxic to plant roots. Adding limestone to acidic soil will also enhance the solubility of phosphate, which becomes more available for plant uptake as the pH approaches neutral. Finally, limestone will provide a valuable source of calcium, which is frequently lacking in acidic soils.

Limestone requires acidity to rapidly dissolve in soil. In regions where the soil pH is greater than 6.5, limestone dissolves very slowly or not at all. Areas with naturally occurring limestone are classified as having calcareous soils. If there is a need to supply large amounts of supplemental calcium in non-acidic soils, gypsum (calcium sulfate) is commonly used. Although gypsum does not rapidly dissolve in soil, it supplies more soluble calcium than limestone in neutral and alkaline soils.

IPNI recently released a publication entitled: *Soil Acidity Evaluation & Management*, which provides an overview of issues related to acidity. More information can be found at the IPNI website: http://info.ipni.net/IPNI-3353.

– RLM –

For more information, contact Dr. Robert Mikkelsen, IPNI Director, North America Program, Ph: 770-825-8070; E-mail: rmikkelsen@ipni.net.

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NITROGEN DOESN'T DO WELL ON ITS OWN

Nitrogen (N) is a plant nutrient that is essential for higher yields and for increased farmer profits, but if other nutritional needs of the crop are unmet, its benefits are reduced. Consequently, farmers and their advisers must ensure crops are getting complete nutrition to make the most of their nitrogen applications.

Cereal crops like rice, wheat, and corn get the nitrogen they need from either the supply in the soil or from other sources like fertilizer and manure. When the nitrogen supply in the soil is insufficient, these crops will produce a fraction of what they could yield if supplied with enough.

How much will yield increase for each pound of nitrogen applied? It depends. Examples are shown in column two in the table below. They range from 0.09 bushels of sorghum grain per pound of nitrogen to 0.36 bushels of corn grain per pound of nitrogen.

Increase in agronomic efficiency of nitrogen for several cereal crops when phosphorus and potassium were applied.

	Yield increase per pound of applied N		
Crop	N alone	N plus P and K	Increase from the additional P and K
	(bushels of grain per pound of applied N)		(%)
Rice (wet season)	0.31	0.60	93
Rice (summer)	0.24	1.8	636
Wheat	0.18	0.33	82
Corn (maize)	0.36	0.70	95
Sorghum	0.09	0.22	140

Ladha, J.K. et al. 2003. Adv. Agron. 87:85-156. Abbreviations: bu = bushel, N = nitrogen, P = phosphorus, K = potassium.

What is striking about this table is what happens to yields when other needed nutrients are also applied. Looking at columns three and four show that yield increases were magnified by applying phosphorus (P) and potassium (K). For example, applying P and K produced almost twice as much corn grain per pound of N compared to adding N by itself.

While individual results will vary, there is a basic principle here. When other nutritional needs are met, plants use nitrogen more efficiently.

Complete nutrition does not mean applying every nutrient. Soils can supply all or just some of what is needed. Soil and tissue testing help assess the level of fertility in the soil and provide useful guidance on whether or not to apply other nutrients. The key is to keep in mind that plants need more than just nitrogen. Making sure that each crop is getting all the nutrients it needs makes the most efficient use of each nutrient that must be applied.

–TSM –

For more information, contact Dr. T. Scott Murrell, IPNI Director, North American Program, Ph: 765-413-3343; E-mail: smurrell@ipni.net.

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VARIABILITY IN SOIL TEST POTASSIUM

Many fertilizer recommendations are made based on a composite soil sample representing the average fertility of the entire field. This approach fails to address the spatial variability of nutrients in the field resulting from changes in soil type, topography, previous cropping history, and many other factors. Even precision farming strategies such as management zones fail to account for all of the spatial variability found in agricultural fields.

A study conducted on Oklahoma demonstrated that the field element size, or the shortest distance where a significant change in soil nutrient availability occurs, was 9ft^2. Soil samples were collected from an established bermudagrass pasture on a 1x1-ft grid from a 490-ft^2 area. Samples consisted of eight 6-in cores/ft^2. The mean soil test potassium (K) value for the entire area was 131 ppm, which would be considered 100% sufficient for bermudagrass production and no K fertilizer would be recommended. However, the soil test values ranged from 12 to 301 ppm K, resulting in several zones within the test area needing as much as 140 lb K_2O/A. A similar study was conducted in Kentucky cornfields and found 2 to 3-fold differences in soil test K (STK) values within a 0.22-A area sampled on a 0.01-A grid.

Considering the high degree of micro-variability in agricultural fields, how can we ensure an accurate estimate of STK? An analysis of data collected by Dr. Bob Miller, Colorado State University, suggests that a minimum of 10 soil cores should be collected from a grid-point sampled area to minimize relative standard deviation about the mean fertility level within a management zone. This minimum number applies to any grid size and becomes even more important in fields with lower average STK levels.

Soil test K can also be highly variable for a field depending on the timing of sample collection. Patterns in STK exist in many regions that show a decline during the growing season due to crop uptake, increasing values over winter as crop residues release K, and a subsequent decline during the next growing season. However, this cycle is often disrupted due to rainfall patterns. For example, dry conditions following harvest and throughout the winter will result in less K being released from plant residue and lower estimates of STK than will likely be available for the next crop.

The amount and type of clay in the soil can also affect STK measurements. This is especially relevant when sampling dry soils with high 2:1 clay content. On low K-testing soils, sampling 2:1 clays when dry will generally result in an over-estimation of STK. Conversely, STK will generally be under-estimated on high K-testing soils. This variability can also be introduced by drying samples in the laboratory prior to analyses. However, the variation due to clay content and soil moisture can be managed by using a field-moist test for K. Results from more than 300 corn and soybean trials conducted by Iowa State University show that the relationship between STK and crop response to K fertilizer in Iowa is much better when using a field-moist soil test.

To minimize variation in STK, consider the following:

- Collect an adequate number of soil samples to accurately represent the field or management zone.
- Establish consistency in the timing of sample collection.
  - Avoid unusually wet or dry periods.
  - Be aware of the effect of residue decomposition on STK.
- Rely more on soil test trends rather than a single year for STK.
- Consider supplementing the soil test report with nutrient removal estimates from the previous crop (https://www.ipni.net/app/calculator/home) when determining K requirements for the current crop.

– SBP –

For more information, contact Dr. Steve Phillips, IPNI Director, North America Program, Ph: 256-529-9932; E-mail: sphillips@ipni.net.

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Winter 2014/15, No. 7

QUALITY ALFALFA REQUIRES GOOD FERTILITY

Alfalfa remains one of the country's major forage crops, despite having a rough go of it in recent years. In 2012, harvested area of alfalfa hay fell to about 17.3 million acres, the lowest since 1942 according to government statistics. The effects of drought and high grain prices were mostly to blame. But since then harvested area has clicked up by almost a million acres (NASS Quick Stats, Oct. 2014).

There are many factors that affect alfalfa yield and quality, whether it is for hay, silage or pasture. Some of these factors, like rainfall and temperature, are uncontrollable; however, other factors are to some degree controllable, and can be carefully managed. For example, alfalfa is relatively sensitive to soil acidity, and does best in soil pH range of 6.5 to 7.5. The bacteria that fix atmospheric nitrogen for alfalfa do best in this soil pH range. Soil acidity issues can be corrected with liming, and should be addressed before planting. Crop nutrition and the provision for an adequate supply of nutrients is another of the controllable and critical factors in the production of quality alfalfa.

In most areas alfalfa begins growth in the early spring and continues into the late fall, resulting in a continuous nutrient demand on the soil for several months. While the figures can be quite variable, data published in IPNI's 4R Plant Nutrition Manual indicates that alfalfa hay removes about 51 lb N, 12 lb P_2O_5, 49 lb K_2O, and 5 lb of S per ton of production. Rhizobium bacteria on well-nodulated alfalfa can fix enough nitrogen (N) to meet crop needs, although a newly planted crop may require some N fertilizer (15 to 20 lb N/A) until nodulation occurs. On the other hand, soil supplies of phosphorus (P), potassium (K), and other nutrients can be rapidly depleted from alfalfa fields if not replaced by fertilization.

Phosphorus performs several vital functions in alfalfa plants. It can impact stand establishment by encouraging root growth, and adequate P has been shown to support higher nodule numbers and nodule health essential for protein production. Plant regrowth and recovery after cutting is more rapid with adequate P, compared with deficient P conditions. It is well known that movement of P in soils is limited, so it's usually recommended to apply as much of the crop's anticipated need as reasonable through preplant incorporated application.

Alfalfa takes up and removes large amounts of potassium, in fact more is removed by alfalfa than any other soil nutrient. Alfalfa forage may contain 2 to 3% K. Potassium has many critical roles in plant growth and development. It has long been recognized as a factor affecting disease incidence, and has an important role in enhancing nitrogen fixation. Adequate K also helps to improve stand persistence and winter survival.

Sulfur (S) deficiency in alfalfa results in reduced yield, crude protein content, and feed value. It is most likely to occur in high rainfall areas, sandy soils, and under irrigation where the concentration of dissolved S in irrigation water is low. Input of other nutrients such as zinc and boron may be needed in some cases.

Alfalfa provides excellent forage, and stands can remain productive for years with proper care and nutrition. When considering fertilizer inputs remember that not all yield and quality compromising deficiencies are visible to the naked eye. To help make the best fertilization decisions for specific circumstances use tools such as soil testing, plant analyses, local information, and nutrient input and removal history.

– WMS –

For more information, contact Dr. W.M. (Mike) Stewart, IPNI Director, North American Program, Ph: 210-764-1588. E-mail: mstewart@ipni.net.