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

From Scientific Staff of the
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Summer 2014, No. 1

FERTILIZERS FOR FOOD AND NUTRITION SECURITY

The use of fertilizer contributes in a big way to food and nutrition security. It is estimated that at least half of the world's population now depends on fertilizer for growing their food supply. Increasing agricultural productivity over the last 50 years has contributed to making more people food secure than ever before. However, large areas of the world still suffer from chronic hunger and persistent shortages, and micronutrient deficiencies affect the lives of over two billion people. The strategy for sustainably intensifying food production must direct fertilizer stewardship to improve human nutrition security.

Considerable history lies behind the term "food and nutrition security". In 1943, representatives of 44 nations gathered in Virginia to consider the goal of "freedom from want" in relation to food and agriculture. According to the Committee on World Food Security of the United Nations, they concluded it meant a secure, adequate and suitable supply of food. "Secure" meant access to food, "adequate" meant enough supply, and "suitable" referred to its quality in terms of nutrient content. In the war-torn Europe of the day, the prevailing levels of hunger focused attention mainly on calories and protein.

By the mid-1990s, "food and nutrition security" had come to mean more than just access. It had become a measure of people actually having gained adequate nutritional status. To achieve it therefore required more than just increased production; it would entail as well education and motivation for people to consume the right foods, along with fitness, health and sanitation improvements to ensure that those consuming the foods could absorb and utilize them.

Food and nutrition security also addresses the "triple burden" of malnutrition: first, hunger, or insufficient intake of dietary energy; second, hidden hunger, related to deficiency of micronutrients, vitamins and trace elements; and third, overweight and obesity, arising from excess intake of dietary energy. The number of people in the first category has declined from over one billion to 842 million globally, over the past 21 years. While more than 98% of them are found in developing countries, governments in Canada and the U.S. still report substantial percentages—7% to 14%—of their populations that are "food insecure" as well. Globally, people in the second and third categories greatly outnumber those in the first.

How is all of this relevant to fertilizer use?

First, fertilizers are improving both the quantity and quality of food. Many of the minerals essential for plant growth are also essential or beneficial for human health. A farm's adaptive management cycle can assess the outcome of plant nutrition decisions in terms of the nutritional qualities of its crops as well as their quantities. Fertilizing cereals with zinc (Zn), for example, increases Zn availability in the human diet.

Second, on a more strategic level, farmers and the service providers that support them can consider how to diversify agriculture to better meet human nutritional needs. Many malnutrition issues are due not to an overall shortage or surplus, but to lack of balance – not enough production of the crops needed for health, and too much consumption of those that, in excess, diminish human health. The fertilizer industry seeks to become the plant nutrition resource for those working to align agriculture's production to current human nutritional needs.

Third, the fertilizer industry recognizes that sustainable agricultural intensification minimizes the losses of fertilizer nutrients that might affect the health of ecosystems on which human health depends.

Improving food and nutrition security comprises a grand challenge that continues to demand attention. The fertilizer industry, along with many sectors including those beyond agriculture, plays an important role.

– TWB –

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DON'T NEGLECT NUTRIENT APPLICATIONS FOR FORAGE CROPS

Of all the crops grown on farmer's fields, forage crops tend to utilize and remove large amounts of nutrients. The majority of top growth for these crops is removed as part of harvesting. In most grain crops, only the harvested grain and associated nutrients are exported from a field, leaving and spreading the crop residues (chaff and straw) back to the soil surface. These residues contain crop nutrients that are recycled into the soil during normal decomposition processes. Table 1 provides a comparison of how barley used as a silage crop removes more nutrients, compared to a barley crop managed as a grain crop. Also included for comparison is a similarly yielding alfalfa hay crop.

Table 1. Nutrient Removal of a Barley Crop, Used for Silage or Grain, lb/bu

Crop	Removal of nutrients, lb/A			
	N	P_2O_5	K_2O	S
[1]Barley grain, 85 bu/A	84	34	27	7.7
[2]Barley silage, 4.5 t/A (approx. 85 bu/A grain equivalent)	155	53	123	18
[1]Alfalfa Hay Crop, 4.5 t/A (DM)	230	54	220	24

[1]IPNI Nutrient Removal Calculator http://ipni.info/calculator; [2]Adapted from Nutrient Uptake and Removal by Field Crops: Western Canada. Canadian Fertilizer Institute. 2001. DM = Dry matter yield

Replacement of nutrients removed in forage crops is important to the long-term nutrient status of soils. As shown in Table 1, a barley silage crop removes almost twice as much N, P and S compared to a barley grain crop. Additionally there is almost five times as much K removed. Unfortunately many forage crops do not receive nutrient additions in balance compared to the volume of nutrients removed. Because of this the forage yields of long-term hay or silage stands tend to decrease over time, and if the forage stand is terminated and the field is rotated into a grain crop there is often a need to add higher than normal rates of nutrients using fertilizer or manure to achieve wanted and expected yields.

I find that the hesitancy on the part of farmers and ranchers to balance nutrient removals with nutrient additions for forage crops is due to an undervaluing of the forage grown. I was involved in a fertilizer research demonstration project on a ranch near Invermere, BC. The ranch manager complained to the local fertilizer retailer that he didn't think they got a sufficient increase in forage yields from applied fertilizer, and asked if there was a way to show that spending for fertilizer was economically beneficial. This was on a mixed stand of grass and alfalfa fields or pastures (50% grass and 50% alfalfa) that were normally grazed until mid July and then allowed to grow for hay cut in early September. I helped the retail agronomist to set out a simple fertilizer response trial, in order to accurately measure the effect on forage hay yields. The addition of fertilizer increased the yield to 4.5 t/A compared to 2.9 t/A where no fertilizer was applied.Using local costs for fertilizer and value of hay, the net return of the fertilizer applied was calculated as follows. The fertilizer cost was $34.50/A, for 75 lb N, 60 lb P_2O_5, 100 K_2O, 30 S, and 1 lb B. Hay yield was increased by 1.6 t/A and the value of hay was $80/t. The value of the increased hay yield was 1.6 t x $80/t for $128/A. The net return was $93.20/A, a return of $2.7 for every dollar invested in fertilizer, an excellent amount of realized profit.

In my opinion farmers and ranchers are often missing out on potential increases in forage yields and increased net returns by not optimally fertilizing their forage crops. It is interesting to me that I was asked to attend a series of alfalfa production seminars in a ranching area of central BC, this past winter. I gave a presentation on alfalfa nutrition management. There is considerable interest in growing higher yielding and improved quality alfalfa for a growing export hay industry. Many ranchers and farmers who were previously hesitant to apply much fertilizer on their alfalfa crops are now motivated to grow higher yields. It wasn't that fertilizing forage crops wasn't economic previously, as shown in the example above, but with hay prices even higher for the export market, the increased motivation to apply more nutrients is there. I recommend all farmers and ranchers work with their local ag-retail agronomist and evaluate the return on investment of fertilizer applied to forage crops. The net returns are usually surprisingly positive.

– TLJ –

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Abbreviations: N = nitrogen.

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Summer 2014, No. 3

NUTRIENT DEFICIENCY SYMPTOMS… DON'T WAIT UNTIL YOU SEE THEM

Plant nutrient deficiency symptoms begin to appear when one of the essential nutrients is lacking. Sometimes deficiencies appear early in the growing season when soils are cold or wet, and when root activity is low. Deficiencies are also commonly observed later in the season when the soil cannot satisfy the high nutrient demand of a rapidly growing crop. Whether the deficiency is caused by poor root uptake or low nutrient-supplying power of the soil, proper management practices can help alleviate these problems.

Deficient plants do not initially show any obvious symptoms of nutrient shortage other than slower growth, which can also be due to many factors. In the case of a mild deficiency, plants may never show a visual symptom except slow growth and reduced yield.

Nutrient deficiency causes a disruption in any number of essential metabolic processes within the plant. Crops mature unevenly because deficiencies rarely occur uniformly across entire fields. This leads to lower yield, harvesting difficulties and poorer crop quality. And as previously stated, this can all occur without diagnostic symptoms appearing.

When deficiency symptoms become noticeable, severe stress is already occurring and steps should be considered to overcome the problem, if it is practical and economical to do. The effects of other stresses such as drought and pests can complicate diagnoses. Another problem is that not all deficiencies produce clear-cut symptoms. Then there is the possibility of multiple deficiencies. The most severe deficiency may be manifested first. Knowing which nutrients are mobile or immobile within the plant is helpful in pinpointing the cause of the deficiency symptom. Diagnosing symptoms also requires understanding of specific crop colors and markers. It is worth noting that some crops are more susceptible to visible symptoms than others.

Plant analysis (tissue testing) is useful for diagnosing specific nutrient deficiencies as they arise. It is best when nutrient concentrations in deficient plants growing in problem areas are compared with healthy plants to identify the differences. It is also helpful to collect soil samples for analysis from the two areas at the time the plant samples are collected.

Tissue testing also is valuable for monitoring plant health during the season to verify that nutrient concentrations do not drop below nor exceed established critical values. Guidelines have been developed for many crops for what the appropriate nutrient concentrations should be during various growth stages. Supplemental fertilization should be considered if the concentrations fall below these established thresholds.

Pre-season soil testing should also be part of a strategy for preventing nutrient shortages. In addition to helping avoid plant stress, soil analysis will allow decisions to be made that will avoid over or under application of fertilizer and resulting economic inefficiency.

The International Plant Nutrition Institute (IPNI) has a large database of nutrient deficiency images that is continually growing. Visit the website at: http://media.ipni.net. Additionally, a collection of over 500 of our best plant nutrient deficiency photos is available for purchase at http://ipni.info/nutrientimagecollection. A condensed version of this collection is available as an app for iPhones and iPads at http://www.ipni.net/article/IPNI-3273.

When nutrient deficiency symptoms appear, first act quickly to diagnose the problem and then make plans to correct it and to avoid having them reoccur in the future.

– RLM –

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GET YOUR OWN NUTRIENT REMOVAL NUMBERS

How much of each nutrient is removed when I harvest grain? This is one of the most commonly asked questions in nutrient management. It is a key component of planning manure applications and calculating "maintenance" rates of fertilizer. The most common sources of this information are tables of standard values, which many university Extension services publish; however, you can generate your own values that are tailored to the hybrids and varieties you grow and the conditions in which you grow them. There are three basic steps.

Step 1. Take a representative grain sample. There are many good sources of information for doing it. One is the USDA Grain Inspection, Packers, & Stockyards Administration, and their procedures are found at http://www.gipsa.usda.gov/publications/fgis/ref/practical_sampling.pdf.

Step 2. Send your sample to a laboratory that has sound quality control and quality assurance programs. Often, the same laboratory you send your soil samples to will also analyze your grain.

Step 3. Convert the numbers you get from the laboratory to nutrient removal rates. This basically involves dividing the percentages you get from the laboratory by one hundred and multiplying by the pounds of dry matter in a bushel. To provide a quick reference, the table below combines those calculations into just one number that you need to multiply your lab results by.

For instance, if the laboratory reports that your corn grain sample contained 0.30% P, you locate the appropriate factor, in this case P (%) for corn is 1.084, and multiply that factor by the lab result: 0.30 x 1.084 = 0.33 lb P_2O_5/bu.

To convert:	to:	Multiply laboratory analysis by:		
		Corn	Soybean	Wheat
N, %	lb N/bu	0.4732	0.5220	0.5190
P, %	lb P_2O_5/bu	1.084	1.195	1.189
K, %	lb K_2O/bu	0.5678	0.6264	0.6228
Ca, %	lb Ca/bu	0.4732	0.5220	0.5190
Mg, %	lb Mg/bu	0.4732	0.5220	0.5190
S, %	lb S/bu	0.4732	0.5220	0.5190

Making a habit of taking samples regularly will build up a nice, personalized dataset that will provide you with nutrient removal numbers that are the most accurate for your set of conditions.

–TSM –

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Abbreviations: N = nitrogen; P = phosphorus; K = potassium; S = sulfur; Ca = calcium; Mg = magnesium.

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GRID SOIL SAMPLING: HOW SMALL? HOW OFTEN? HOW USEFUL?

As variable-rate fertilization increases around the U.S., some of the most common questions being asked are related to grid soil sampling. In a grid sampling strategy, the field is divided into areas of a pre-defined size and soil samples are collected from each grid area using one of several sampling strategies, i.e. grid point, grid cell, offset grid point, etc. Like traditional soil sampling, the objective of grid sampling is to assess the nutrient status of the field. The difference is that instead of a single average value for the entire field, a contour map is created using GIS software that shows the range and pattern of soil nutrient status, which is used to establish management zones within the field.

What grid size should I use? This is an important question, as grid size will affect the cost of establishing the program. Ideally, the grid size will be small enough to accurately capture the range of nutrient status in the field; more highly variable fields should use a smaller grid size, while grid size in less variable fields can be larger. Research in Nebraska showed that increasing sampling density from 4.2 to 42 samples/A resulted in 45% of the field receiving a different N fertilizer rate recommendation and the average N fertilizer rate for the entire field was reduced by 14 lb N/A. However at another site, sampling densities of 14 samples/A and 1 sample/3.7A resulted in only 18% of the field receiving a different N recommendation and no change in the average N rate for the field. Choosing a grid size is a bit of a catch-22, as it is helpful to know something about spatial variability in the field to select the optimum grid size; however, the very purpose of grid sampling is to determine spatial variability. Commercial services typically offer grid sampling ranging from 1 to 4 A/sample (8 to 10 soil cores/sample); however, university research suggests that for a soil nutrient map to remain valuable for several years, grid size should be 1 to 1.5 A/sample and not exceed 2.5 A/sample.

How often should I grid sample? As mentioned earlier, a soil nutrient map established at the optimum grid size to accurately capture the spatial variability in a field should last for several years. Multiple university guidelines suggest that grid sampling for P and K be repeated every 4 to 5 years, while pH maps are usually good for 8 to 10 years.

In years between grid sampling, additional data layers can be used to refine management zones and guide directed soil sampling where needed. Knowledge on changes in soil type; yield map data; satellite, crop sensor, or UAS-based imagery; and field scouting knowledge can significantly improve nutrient management decisions. Multiple data layers can help identify non-fertility factors such as compaction, pests, and soil textural changes that may affect nutrient status. Directed soil sampling (a composite sample collected from a specifically targeted management zone) based on multiple data layers can confirm where additional fertilizer is needed due to unusually high crop removal or nutrient losses.

How useful is grid sampling? Considering the challenge of selecting the optimum grid size and the potentially high cost, couldn't I just use directed zone sampling based on other data? Both grid and directed soil sampling are valid options for precision agriculture. Both also have their advantages and disadvantages. Grid sampling can be labor intensive and expensive, and arbitrarily selected grid sizes might not be small enough to accurately capture the nutrient availability in the field. Directed zone sampling is often more economical, but requires field knowledge and a higher skill level to incorporate multiple data layers. Directed soil sampling may also miss fertility patterns that could have been detected with an initial grid sample. Choosing the right precision soil sampling strategy depends on time and cost; who will be doing the work and what support is available; what information is available; and what equipment is available (some variable rate application equipment is controlled by software based on grid samples).

Regardless of the strategy used, precision soil sampling is an effective tool for managing the spatial variability in soil nutrients. Grid and directed zone soil sampling are simple first steps that growers can use to collect valuable information about their farms when establishing a precision agriculture program. Applying fertilizer at the right rate and in the right place in the field based on spatial variability results in a more efficient and effective use of resources that can have economic, environmental, and social benefits for a sustainable agricultural system.

To learn more, make plans to attend the next InfoAg July 29 – July 31 at the Union Station Hilton in downtown St. Louis, MO. Stay informed by visiting www.infoag.org and following @InfoAg.

– SBP –

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WATER NUMERIC NUTRIENT CRITERIA: WHAT, WHY AND THE 4RS

State water quality agencies have the major responsibility of ensuring the protection of water resources from nutrient (N and/or P) pollution. For decades, lake, stream, and river water quality nutrient levels have been periodically monitored by either state agencies or federal agencies.

Historically, most states have relied on narrative nutrient criteria that stipulate that designated uses of water resources shall not be impaired by nutrients. Since about 2000, the U.S. EPA has emphasized the need for more robust numeric nutrient criteria by states, based on sampling of reference waters and human-impacted waters. The EPA has advocated use of overlapping frequency distributions of nutrient levels from least-impacted reference streams/rivers and monitored streams/rivers, in selecting numeric nutrient criteria.

Last year, in its 2013 release of the 2008-2009 National Rivers and Streams Assessment Report on water quality (http://water.epa.gov/type/watersheds/monitoring/aquaticsurvey_index.cfm), the EPA used a more narrowed statistical approach than in the past, in interpreting stream/river quality conditions. Overall, the U.S. EPA found that 55% of the monitored rivers and streams were in poor biological condition. Compared to the 2004 EPA wadeable stream assessment, 7% fewer stream miles were in good biological condition and 19% fewer stream miles were in good condition for P.

The good news was that 9% more stream miles were in good condition for N, 17% more stream miles were in good condition for in-stream fish habitat, and 12% more stream miles were in good condition, as measured by riparian disturbance.

Currently, seven states have statewide or partial N numeric criteria for rivers/streams; while 11 have statewide or partial P numeric criteria for rivers/streams. More states are making progress (http://cfpub.epa.gov/wqsits/nnc-development/), and the number of states with statewide or partial numeric criteria may double by 2016. According to a 2013 paper published in the Journal of Environmental Quality (https://www.agronomy.org/publications/jeq/pdfs/42/4/1002?search-result=1), among the several states with site-specific nutrient criteria for streams and rivers, only Wisconsin and Florida have statewide criteria which are well-supported by peer-reviewed and technical papers documenting the process of criteria development. A number of states have developed new nutrient loss reduction strategies. Several state strategies are designed to primarily encourage agriculture, and other nonpoint or diffuse sources of nutrient loss from land to water resources, to become more aggressive with their best management practice implementation and mitigation actions.

The 12 states adjacent to the Mississippi River are under greater pressures to do even more to reduce the losses of N and P that get transported downstream to the Gulf of Mexico, and which aggravate the early summer development of low dissolved oxygen conditions (hypoxia) in the northern Gulf of Mexico. Each of those 12 states is developing, or has developed, a nutrient loss reduction strategy to further its commitment to improved and protected water quality throughout the Mississippi River Basin and the northern Gulf of Mexico.

More agricultural losses of N and P from nonpoint (diffuse) sources can be curbed, through more timely and wise implementation of 4R (right source at the right rate, time, and place) nutrient management practices. Those 4R practices will be most effective when skillfully combined with in-field and edge-of-field soil and water conservation practices. There is no time like the present to keep more of our applied nutrients in fields and out of water resources.

How will you be adjusting your 4R nutrient management and soil and water conservation plans to be part of the winning water quality solution?

– CSS –

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PLANNING WINTER WHEAT FERTILITY PROGRAMS

Winter wheat is an important crop for the Southern and Central Great Plains Region, it could be argued that it is the most important crop to the region since it dominates total acreage. Planting dates in the region vary by location and purpose of the crop (i.e., grain versus grazing), but for the most part planting begins in earnest during September. Planning and execution of a sound and effective program for wheat nutrition and fertilization is among the most important factors affecting the crop's performance and profitability. Such programs require forethought, and tasks such as soil testing should be done well in advance. Therefore, it's not too early to start planning wheat fertility programs. Below are a few basic points concerning major nutrients in wheat nutrition.

Nitrogen performs many vital functions in the wheat plant. Wheat requires 2 to 2.5 lb N/bu of grain, or, if grazed 1 lb/A for each 3 lb/A animal gain. Shortages of N may cause reduced tillering, reduction in head size, poor grain fill, and low protein content. Adequate N must be available to the wheat plant at all phases of development. Splitting N applications generally improves use efficiency, minimizes risk to investment, and safeguards the environment. Topdress applications should be made early, prior to jointing, to maximize production efficiency. Timing, placement, and N source should be managed to fit climatic conditions, soil type, and tillage system. It should be noted too that in recent years scientists at Oklahoma State University have developed the N Rich Strip as a tool to aid in N fertilizer decisions. For more on this see their website (http://npk.okstate.edu/referencestrips).

Adequate P fertility is associated with increased tillering and grain head numbers, reduced winterkill, and hastened maturity. Winter wheat takes up about 0.6 to 0.7 lb P_2O_5/bu grain produced. Because P is relatively immobile in soils, banded or starter applications are often most effective in soils testing low to medium. Even in high testing soils starter applications may help plants get established more quickly. Banded P also helps young plants overcome the adverse effects of soil acidity. Broadcast P should be incorporated to improve availability and reduce the risk of loss. Phosphorus is second only to N as the nutrient that most commonly limits wheat growth and development.

Potassium is mostly associated with the water economy within the plant and decreased incidence of disease and lodging. The uptake requirement for potash (K_2O) is approximately equal to that of N, about 2 lb/bu. Much of the region's soils test adequate to high in K, but there are wheat-producing areas where soil levels are lower, and application can be beneficial. Placement of K is not as critical as P since it is more mobile in soils. Split applications may be beneficial on low K deep sandy soils in higher rainfall areas.

The importance of secondary and micronutrient nutrition on winter wheat should not be overlooked. The plant available form of S is sulfate, which is mobile in soils. The major native source of S is usually soil organic matter. So, the conditions that favor S shortages are low soil organic matter levels and sandy soil conditions where sulfate is subject to leaching. Several studies over recent years have shown that chloride (Cl^-) application may be beneficial in wheat production. Chloride has been shown to be important in suppression of certain diseases, including leaf rust. Researchers at Kansas State University have been at the forefront of developing Cl- fertilization strategies for winter wheat and other crops. For more on this see their publication entitled *Chloride in Kansas: Plant, Soil and Fertilizer Considerations* (http://www.ksre.ksu.edu/bookstore/pubs/MF2570.pdf).

Profitable and efficient wheat production involves supplying adequate amounts of plant nutrients when and where the crop needs them. Fertilizer application rates are of little value if nutrients are not in the proper place at the proper time. Effective management strategies vary from region to region, but a characteristic of all good soil fertility management programs is early planning and application of 4R principles—application of the right fertilizer rate, at the right time, right place and use of the right source.

– WMS –

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