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

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EVALUATING IMPACTS OF 4R NUTRIENT STEWARDSHIP

Impacts of nutrient stewardship reach far and extend broadly. Nutrients are essential for plant and animal agriculture and comprise a large portion of its outputs. But the starting point for assuring beneficial impacts is the adaptive management built into 4R Nutrient Stewardship.

To manage adaptively means to evaluate impacts in your decision cycle. The metrics you evaluate need to reflect impacts important to your local farming system. Three key outcome metrics are farmland productivity, soil health, and nutrient use efficiency. The three directly relate to nutrient stewardship practices, complement each other well, and connect to the farther-reaching impacts of crop nutrition. Applying the right source of nutrients at the right rate, time and place boosts a cropping system's productivity while maintaining soil health and optimizing nutrient use efficiency.

Fertilizer inputs make cropping systems more productive. They increase yields, and can also increase the nutrient density of crops. Of course, many other crop management factors also influence yield and quality. The same can be said for the health of soils. Soil health depends on maintaining nutrient reserves, as well as practicing soil conservation. Nutrient use efficiency, in the same manner, is influenced by applying the right source of nutrients at the right rate, time and place…but can be influenced just as much by any management factor affecting yield, and by the health of the soil.

Considering the three key metrics together helps the manager seek sustainable synergies. Overemphasis on nutrient use efficiency can lead to nutrient-depleted soils and foregone productivity. Overemphasis on productivity can lead to poor nutrient use efficiency. But when source, rate, time and place decisions are evaluated by all three metrics, the combinations that produce the most sustainable results are favored for adoption.

What are the farther-reaching impacts of crop nutrition? These include water quality, air quality, and carbon footprint. Negative impacts in these three areas arise from nutrient losses, and thus tend to diminish with increases in nutrient use efficiency. But sometimes, choices of source, timing and placement can have larger direct impacts on these end points than on nutrient use efficiency alone. A good example is placing phosphorus (P) in the soil within conservation tillage systems: it reduces loss of dissolved P by a lot more than its impact on crop nutrient uptake.

Going yet further, impacts extend to food and nutrition security, biodiversity, and economic value. Crop nutrition can be managed for positive social benefits in these three areas. Producing more food, and more nutritious food, contributes toward ensuring all are properly nourished. Producing higher yields enables society to spare land for nature. Producing with better practices and with better documentation enhances economic value, providing employment and economic benefit well beyond the farm gate. These extended benefits depend on many more management factors beyond the 4Rs, but the 4Rs make a real and essential contribution.

Crop producers, crop advisers, and agricultural input retailers already engage in adaptive management. We all play a role in communicating to society the broad and far-reaching benefits of continuously seeking the right source, rate, time and place of nutrient application. By better documenting the decision cycle, our current and past practices, and their relation to impacts, the industry has the opportunity to build public trust.

– TWB –

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STRATEGIES TO IMPROVE DISTRIBUTION OF LESS SOIL MOBILE PLANT NUTRIENTS

One of the challenges in making and applying fertilizer blends is that we sometimes make compromises in the way we apply specific nutrients. A major complication is that the 14 mineral plant nutrients differ in mobility in the soil.

Nutrients are grouped into three basic classes of mobility: mobile, somewhat mobile, and immobile. Here the term "immobile" isn't totally accurate as even these nutrients move in soil, just usually very slowly and very short distances, for example an eighth to a quarter of an inch in the year of application. Mobile nutrients can be applied and placed away from were crop roots will grow, and will move one to two feet in distance to crop roots quite easily. Somewhat mobile and immobile nutrients are ideally placed where young crop roots will grow into soil, soon after establishment. Sometimes we apply a less mobile nutrient along with mobile nutrients, away from where young crop roots can assess it, and are disappointed when it is not absorbed well by crop roots.

Nutrient mobility in soil is largely determined by its ionic charge and form. Plant nutrients exist as either negatively charged anions or positively charged cations. The overriding influence in soils is that soil particles (mostly clay size) as well as humus material, have a net negative surface charge. This negative charge will attract cations, and repel anions. Chemical analysis of soils can measure this electrostatic charge, which is called cation exchange capacity (CEC).

Recently developed nutrient forms, additives and management practices are available to improve crop uptake of somewhat mobile and immobile nutrients.

1. If possible apply immobile and somewhat mobile nutrients in the seed furrow blend, and all high rates of mobile nutrients in a sideband or broadcast application.
2. Improve field distribution of lower rates of immobile nutrients, by applying dry powder dressings containing the immobile nutrients as either seed treatments or to seed furrow fertilizer blends.
3. Use recently developed phosphate products designed to improve micronutrient distribution by having each granule contain a low concentration of the needed immobile micronutrient. An example is addition of a low rate of soluble zinc to a compound granule containing primarily monoammonium phosphate.
4. Use of soluble foliar nutrient products can provide low but sufficient rates of immobile micronutrients directly to the leaves of developing crops. This can effectively supply the needed immobile nutrient to all crop plants.

Despite the challenges in optimally applying all needed crop nutrients, there are ways to place immobile and somewhat mobile nutrients so crop seedling roots will intercept, or developing crop leaves can receive, the needed nutrients in the required amounts.

– TLJ –

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Fall 2015, No. 3

YEAR OF SOILS: SOIL DEGRADATION DESTROYS PRODUCTIVITY

Who cares about dirt? Soil is the fragile skin on the earth that provides more than 95% of our food. Soil also provides an essential life-sustaining role in cleaning air and water.

When we lose our soil, many vital functions are also lost. It has been estimated that over 40% of the soil used for agriculture around the world is already degraded or seriously degraded and that half of the topsoil on the earth has been lost during the last 150 years. Soil degradation is the slow decline in land quality caused by human activity. We have plenty of reasons to be concerned with this growing threat to food security.

Soils become degraded from both man-made activities and accelerated natural processes. Some impacts of soil mismanagement and degradation include compaction and poor drainage, depletion of essential plant nutrients, rapid loss of organic matter, accumulation of salts, and acidification. Soil degradation frequently accelerates soil erosion and may result in permanent loss of a soils productive capacity.

Soil degradation is a severe challenge that threatens the sustainability of crop and livestock production worldwide. For example, in sub-Saharan Africa, about 65% of the land area is degraded, with devastating economic and human impacts.

Some major constraints to agricultural productivity in sub-Saharan Africa resulting from soil degradation include soil acidity and aluminum toxicity, nutrient depletion, and soil erosion with resulting shallow soils. The slow process of restoring these soils begins by balanced addition of crop nutrients and lime, adjusting cropping rotations to include cover crops, and adopting practices to halt soil erosion.

A major step in preventing soil degradation is proper use of plant nutrients. Fertilizers replace essential plant nutrients removed in harvested crops, preventing nutrient exhaustion of the soil. Several recent studies show that proper fertilizer use maintains or improves soil microbial activity, boosts inputs of crop residue returned to the soil, and can maintain soil organic matter...all while enhancing crop yields.

The damaging effects of soil erosion are also felt off of the farm. Streams and lakes can become clogged with sediment and nutrients lost from agricultural fields, damaging fish and aquatic life.

Erosion and soil degradation is usually a slow process, easily escaping our attention at first glance. However, their cumulative effects are devastating on many levels. Farmers everywhere should consider how they can protect their precious soil resources. Their livelihood and their neighbors depend on careful stewardship of the soil beneath our feet.

– RLM –

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PLUG INTO A RESEARCH NETWORK

It's nearing harvest time. Driving across the field fuels many questions: Could I have gotten more yield? Did that product really work? Would that new technology have helped?

You're not alone. Everyone else is asking the same thing. If you really want to know, consider plugging yourself into an on-farm research network. Participating has many advantages – not only to you but to all involved. Here are just a few.

Advantages to the grower and adviser:

- Creates informed investment decisions
- Sorts out practices and products that are necessary for increased production
- Provides answers specific to your farm
- Informs improvements to localized recommendations

Advantages to the researcher:

- Expands the scope of the research, providing a greater context in which to interpret findings
- Provides greater statistical power to comparisons when data are combined over locations and years
- Tests whether effects observed in more controlled settings, like growth chambers, greenhouses, or small field plots, are large enough to be detected under noisier field conditions where more factors are left uncontrolled

Advantages to agricultural retailers and manufacturers:

- Demonstrates to customers your dedication to provide them with the best products and information possible
- Informs your product purchases and/or product developments
- Increases customer loyalty and trust

Advantages to all:

- Forms relationships that are mutually beneficial
- Forms a community of individuals committed to finding objective answers using a scientific approach
- Creates a progressive group that is the first to discover what works and what doesn't in production settings
- Makes good use of limited resources through "in-kind" contributions by each participant, such as expertise, equipment, products, and labor
- Provides everyone an opportunity to have a say in what is measured and what practices and products are tested
- Creates greater chances that needed management changes will be adopted

On-farm research networks are on the rise because they offer so many advantages. Consider joining one and being part of a very progressive community dedicated to finding what works and what doesn't.

–TSM –

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

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THE VALUE OF VARIABLE RATE TECHNOLOGY (VRT)

In his presentation at the 2015 InfoAg Conference, Dan Frieberg, President of Premier Crop Services, said of VRT, "Real world agronomy is integrated and complex; we can't make what is truly complex simple – we can make it easy, but not simple." Varying rates of fertilizer, seed, water, and other inputs across the field is the easy part. The challenge lies in choosing the information that goes into defining the management zones (MZ). The days of creating MZ solely from a yield map or grid soil sampling are behind us. Decision-making in precision agriculture (PA) has become more data-driven and our ability to incorporate multiple layers of agronomic data into MZ development is greater than ever before. So, which data layers are most valuable in creating reliable MZ?

Yield monitoring remains one of the most popular and commonly used data layers in defining MZ. Yield maps can provide a measure of the scale and location of variability in the field, but if used alone without properly understanding the data, they can be misleading. In his presentation at InfoAg 2015, Dr. Raj Khosla, professor of PA at Colorado State University, discussed the process of yield mapping, how to eliminate errors in yield maps (e.g., "cleaning" the data), and how to evaluate multiple years of yield data to create reliable "decision maps" for MZ delineation (link provided below). Yield maps are good for answering "where" and "how much" variability exists in the field, but they don't say anything about "why."

Soil fertility and other soil properties are often highly correlated with yield as the "why" in spatial variability. The best way to collect a soil fertility data layer is by grid sampling the field. The *Plant Nutrition Today* article "Grid Soil Sampling: How Small? How Often? How Useful?" (link provided below) addresses several questions about grid sampling procedures, but the consensus is that soil sampling density (e.g., grid size) is critical in developing quality soil maps. Data presented at InfoAg 2015 by Dave Scheiderer of Integrated Ag Services showed that 0.5-A grids were 2 to 4 times more reliable at identifying variability in soil phosphorus, potassium, soil organic matter, and pH than the standard 2.5-A grids. Smaller grids are more costly, but several currently available options in automated sampling are making high-resolution sampling more economical.

Soil texture, moisture, SOM, slope, elevation, and farmer experience have all been used to create more robust and reliable MZ. Various methods have been used to collect these data such as soil sampling, bare soil and crop imagery from satellites, planes, and UAVs, and soil EC/EM mapping. One data layer that many experts agree does not add much value to MZ delineation is a standard soil classification map. "Soil type doesn't tell us much about yield variability in a field because the mapping units are too heterogeneous," says Dr. Jason Warren, soil conservation specialist at Oklahoma State University. "The original soil maps were never intended to be used the way we try to use them in precision ag."

If our current ability to define robust, sophisticated MZ is so easy and reliable, then why aren't more growers using VRT? According to the Purdue/CropLife PA survey, almost 70% of retailer respondents offer VR fertilizer services and 50% offer VR seeding, but only 30% and 14% of the market area is using the two services, respectively. Why? The status quo has been to sell growers a VR prescription without any mechanism in place to evaluate the ROI. Enter the Learning Block™ concept presented by Dan Frieberg at InfoAg 2015 (link provided below). By establishing high and low input checks within MZ, growers have access to quantifiable, low-risk results to answer the "Did it pay?" question. Data from millions of acres where Learning Blocks were used show that VRT frequently results in profits for the grower.

Links Mentioned

Dr. Khosla on cleaning yield map data >http://infoag.org/abstract_papers/papers/paper_328.pdf<

Grid Soil Sampling: How Small? How Often? How Useful?" >http://info.ipni.net/PNT-NA-2014-2<

Frieberg's Learning Block™ concept >http://infoag.org/abstract_papers/papers/paper_323.pdf<

– SBP –

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POTASH ORIGIN AND SOURCES

Potassium (K) in agriculture is often loosely referred to as potash. The term potash comes from an early production technique where K was leached from wood ashes and concentrated by evaporating the leachate in large iron pots. This method depended on tree roots to mine K from soils, which was then recovered after wood was harvested and burned. The K collected was in the form of potassium carbonate, which was used as fertilizer and in the manufacture of various products including glass and soap. Interestingly, the first patent granted in the USA (1790) was for potash production. Potash collection in this era was usually a secondary endeavor, with land clearing for farming being the primary goal of tree removal. Needless to say, this means of potash production was not sustainable.

Today K is produced in many parts of the world, with underground salt deposits—mostly a combination of K and sodium (Na) chloride—being the main source. These deposits were formed as ancient oceans evaporated, leaving behind concentrated salt layers that were subsequently buried by sediment. Many countries contain such deposits, with the largest being in western Canada. Extraction of K salts from these deposits is mostly accomplished by conventional shaft mining techniques; however, solution mining may be used in circumstances where shaft mining is prohibitive. Also, some naturally occurring surface-water brines (e.g., Great Salt Lake in Utah, Dead Sea bordering Jordan and Israel) contain sufficient K salts to make extraction feasible. With these surface brines solar evaporation is used to concentrate the salts before harvesting. All total, over 90% of modern global potash production goes into the manufacture of fertilizer.

Although there are many K fertilizer sources available, by far the most common is muriate of potash or potassium chloride (MOP; KCl). Other sources of K include potassium sulfate or sulfate of potash (SOP; K_2SO_4), potassium magnesium sulfate ($K_2SO_4 \cdot 2MgSO_4$), potassium nitrate (KNO_3), potassium thiosulfate (KTS; $K_2S_2O_3$), and less common sources such as potassium phosphate (KH_2PO_4), potassium carbonate (K_2CO_3), and potassium hydroxide (KOH). With the exception of the last two, all of these K sources contain other mineral nutrients essential for plant growth [chloride (Cl^-), sulfur (S), magnesium (Mg), nitrogen (N), and phosphorus (P)].

Once the need for K fertilizer has been established, price and availability are usually the factors governing which source is the most desirable. Since KCl is the most abundant, it is almost always the most accessible and cheapest per unit of K. There are however circumstances where simple price and availability are overridden by other concerns. These circumstances may include:

- Crop sensitivity to Cl^- – Some crops are less tolerant of Cl^- than others. Examples of sensitive crops are avocado, lettuce, peach, and tobacco. With the exception of certain soybean varieties, Cl^- sensitivity among common row crops and small grains is usually not an issue.
- Salt index – The salt index of a fertilizer is simply a measure of salt injury potential, and is mainly a concern when fertilizer is applied to sensitive and/or high value crops. It may also be a concern in saline soils or where saline irrigation water is used. More detail on salt index is available in most basic agronomy texts.
- The need for other nutrients – For example, if the need for Mg has been established then potassium magnesium sulfate may be the best choice.

Potash production has come a long way… from wood ash leaching during the early days, to modern large-scale mining operations that extract naturally occurring K bearing minerals.

Potassium fertilizer is more than ever critical to the production of sufficient and high quality crops to accommodate an expanding global population.

For more information on specific fertilizer materials see IPNI's Nutrient Source Specifics series at http://www.ipni.net/specifics-en

– WMS –

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