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

From Scientific Staff of the
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Winter 2010-2011, No. 1

SOIL FERTILITY SHIFTS IN RESPONSE TO CROP NUTRIENT BALANCE

Soil fertility rises and falls in response to crop nutrient balances. Nutrient surpluses raise soil test levels; deficits draw them down. It's not always easy to predict how much, or what the consequences will be, so it's important for the crop manager to monitor both as closely as possible. Recent surveys of soil tests and nutrient balances on the state and province scale point to the need to pay close attention to the same on the farm and field scale.

A new soil test summary is out. The International Plant Nutrition Institute recently completed a survey of the public and private soil test laboratories of North America, similar to surveys done every 4 to 5 years for the past several decades by the Potash & Phosphate Institute. There are numerous challenges to conducting such surveys, since soil test methods and interpretations vary among states and provinces, and change over time as well. Nevertheless, important and consequential trends are showing up.

The 2010 survey included more samples than any previous survey. An estimated 4.4 million soil samples were submitted across North America for this survey compared to about 3.4 million for 2005. The increase likely reflects more widespread and intensive soil sampling by producers, arising from higher and more rapidly fluctuating prices for fertilizers and crop commodities seen in recent years.

In Eastern Canada and the northeastern United States, the soil fertility shifts varied. In many areas, soil test levels for K have moved downward since 2005. For example, in the province of Ontario the proportion of soils testing 80 ppm or less in K grew from 15% in 2005 to 20% in 2010. Soils testing in this range are likely to produce K deficiencies in almost any crop in the absence of fertilization. This trend is not surprising, considering that the amount of K applied to Ontario cropland in the form of fertilizer and manure was only about half that removed by crops in 2009.

However, elsewhere the shifts varied in size and direction. In Pennsylvania, the distribution of soil test K hardly changed at all, while in New York and Virginia, it appears to have shifted upwards.

Soil test P levels often fall into a bimodal distribution. A substantial proportion are in the responsive range, but another large proportion are at levels far above the critical level for crop response. The very high levels result from many years of historical nutrient surpluses. Such soils need to be managed in ways that eliminate the surplus, maximize utilization of the P fertility for the benefit of crop production, and minimize surface runoff and erosion to protect water quality. The frequency of very high soil P tests continued to decline in Ontario, but increased in New York, New England, and Pennsylvania.

The soils of the region remain quite variable in fertility. Even in states and provinces with overall nutrient surpluses, many soils needing nutrient additions can be found. On the other hand, many soils have built up fertility to the point where inputs of P and K amounting to less than crop removal of the nutrient can continue for years. Of course, in such situations it would be important to monitor the decline with regular soil testing.

So, nutrient decisions need to be supported not only by crop nutrient balances, and not only by soil tests, but by both. Using the two tools, you can manage nutrients sustainably.

More detailed information on these changing nutrient balances and soil test levels can be found at this site: **http://nane.ipni.net**.

—TWB—

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Abbreviations: K = potassium; P = phosphorus; ppm = parts per million.

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

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THE ROLE OF POTASSIUM IN REDUCING THE INCIDENCE OF CROP DISEASES

Potassium is essential for all plants. It is considered one of the macronutrients, along with N and P, because it is used in relatively large amounts compared to other nutrients. For example, an 80 bu/A barley crop will take up about 106 lb N, 43 lb P_2O_5 and 93 lb K_2O. Barley grain contains the majority of the N and P, with 74% and 79%, respectively. The majority of K, about 74%, is in the straw or residue of the crop. Although K is important to many vital plant functions such as plant enzyme activation, water regulation, energy capture from photosynthesis, N uptake and protein synthesis, starch synthesis, and root growth, K is not part of plant manufactured components such as proteins and oils. However, it also contributes to grain or fruit quality, helps prevent lodging, and increases crop disease resistance.

The simple explanation for increasing crop resistance to plant diseases is that by providing balanced plant nutrition, including adequate K, crop plants are healthier. A healthy plant is more able to resist invasion by disease organisms, and recover from a disease episode. However, besides just being healthier, there are other ways that K specifically helps plants resist disease.

Potassium helps crop plants resist disease organism invasion or penetration by strengthening cell wall structure. Plants having adequate K will have thicker cell walls compared to plants deficient in K. This makes it harder for disease organisms to penetrate plant cells and establish an infection. This applies to fungal, bacterial, nematode, insect, and viral disease organisms. Another indirect benefit from stronger cell walls is that plants are less prone to lodging, and stem and leaf architecture is more upright and spread out, thus improving airflow through the crop canopy. This can help slow down the spread of any disease organism through the crop canopy, and result in lower humidity levels that can reduce the growth of pests and diseases that prefer moist environments.

Potassium is also vital for water regulation in plant cells. There are two mechanisms of water regulation that help plants better resist disease establishment. Potassium is important for stomate cell regulation for pore openings on plant leaves. Adequate K nutrition will allow the plant to maintain smaller stomatal openings compared to a K-deficient plant, and also pores are opened and closed more easily and timely, which helps limit the successful invasion of disease organisms into plant leaves. The second water regulation mechanism that can help reduce disease organism penetration into plant cells is that adequate K nutrition helps the plant to maintain increased turgor, or water pressure in cells. A cell with optimum turgor pressure will tend to push organisms away from the cell membrane when the invading organism attempts to push through the cell membrane.

Adequate K in plant cells improves utilization of the building components required for synthesis of starches and proteins. This results in a lower concentration of low molecular weight carbohydrates such as sugars in plant cells. Many disease organism growth rates are increased if there is an ample supply of simple sugars or carbohydrates compared to larger structures such as starches. In a similar way, complex protein structures are more slowly utilized by many disease organisms, whereas higher concentrations of mineral N in the form of ammonium and nitrate, or N contained in basic amino acids, can facilitate more rapid disease organism growth.

Incidence of crop diseases can be reduced if attention is given to supplying crops with adequate supplies of K. There are two ways to assess whether or not a crop will have, or does have, adequate K. Soil testing for plant available K can show whether or not more K should be applied as fertilizer prior to planting. Plant sampling and tissue testing of crop plants during the growing season might show less than optimum levels of K in plant tissues, and increased K fertilizer rates should be considered for future short-season annual crops. In the case of long-season or perennial crops, there may be a benefit to topdressing K. Advice can be obtained from your local consulting agronomist or certified crop adviser, or from a soil and plant testing laboratory agronomist, to know whether or not K fertilizer might be beneficial.

—TLJ—

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Abbreviations: N = nitrogen; P = phosphorus; K = potassium.

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WHAT SULFUR SOURCE SHOULD I USE?

Sulfur has been recognized as restricting crop production in parts of the world. Soil S budgets are negative in many areas, where more S is removed from the field in harvested crops than is supplied by various inputs. Much of the S in soil is present in organic matter, where it is unavailable for plant uptake until it is converted to sulfate. Plants require adequate S for many reactions, including synthesis of proteins and enzymes.

When additional S is needed to meet crop needs, there are many excellent sources of this nutrient. Elemental S was once mined directly from the earth. It is now more typically obtained from coal, crude oil, and natural gas during refining or during scrubbing of combustion gases. A number of common earth minerals are also used as S sources for agriculture.

Elemental S is not water soluble and must be oxidized by soil bacteria to sulfate before it can be taken up by plant roots. The speed of this microbial process is governed by environmental factors such as soil temperature and moisture, as well as the physical properties of the S.

Various approaches have been used to enhance the conversion of elemental S to plant-available sulfate. The speed of elemental S oxidation is directly related to the particle size, where smaller particles have a greater surface area for the soil bacteria to act on. Therefore, large particles of S may require months or years of biological action before oxidizing significant amounts of sulfate. Fine, dust-sized particles are oxidized quickly, but are not easy to apply.

One approach to enhance the rate of S oxidation is to add a small amount of clay to the molten S prior to cooling and forming small pellets ("pastilles"). When added to soil, the clay swells with water and the pastille disintegrates into fine particles that are rapidly oxidized.

Very thin layers of elemental S can be incorporated during fertilizer granule manufacturing. This S is quick to oxidize and become available for plant uptake. This reaction can have a positive impact on the plant availability of some micronutrients, such as zinc and iron, which become more soluble as the pH declines. Finely ground elemental S is sometimes added to fertilizer suspensions. Elemental S is also used as a fungicide for crop protection. Elemental S and sulfuric acid are commonly used in the reclamation of calcareous soils that contain elevated sodium and in the treatment of irrigation water containing excessive bicarbonate.

A number of excellent soluble sulfate fertilizers are available to provide a rapid supply of nutrients. The selection of a particular soluble material depends on price, availability, form, and the other nutrients that accompany the sulfate. A few examples of commonly used S fertilizers include:

Non-Soluble	–	Elemental S
Semi-Soluble	–	Gypsum (15 to 17% S)
Soluble	–	Ammonium sulfate (24% S); Epsom salt (13%); Kieserite (23% S); Langbeinite (22% S); Potassium sulfate (18% S); Thiosulfate (10 to 26% S)

—RLM—

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Abbreviation: S = sulfur.

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STARTER FERTILIZER – WHY IT'S DONE

Starter fertilizer. It's not the easiest practice to put into place – special attachments, more cost, and logistics of tending tanks or bins to name a few. But many farmers make it a part of their regular planting practices. Why?

First, with starter fertilizer, a little goes a long way. Because it is placed near the seed at planting, it is accessible to a young root system. For some crops, like corn and wheat, roots take up nutrients at the fastest rate early in the season. A concentrated supply of nutrients within easy reach of a limited root system increases the chances that roots can continue to take up nutrients at a rapid rate without running short. Because they are strategically placed and timed, starter fertilizers are one of the more efficient applications made.

Starter fertilizers can be used as a strategy for managing within-field nutrient variability. It has been shown time and again that soil fertility varies across the field and so does crop response to applied nutrients. Agriculture is able to measure and document this variability more than in the past. However, site-specific approaches still carry risk that some areas of the field may not be properly characterized and under-fertilized. Applying a small quantity of nutrients across the entire field as starter fertilizer helps manage this risk.

Nutrients in starter fertilizer provide synergistic effects. Nitrogen and P can cause roots to proliferate in the zone where starter fertilizer was applied. Potassium does not proliferate roots, so co-application with N and/or P is needed for roots to more fully explore the K supply in the starter. Nitrogen, in the ammonium form, results in acidification of the zone of soil right around the root. This lower acidity has been shown to increase P uptake by young plants. Phosphorus also supplies needed energy early in the plant for the active uptake of K.

The most commonly observed effect of starter fertilizer is more rapid early season growth. While this response is probably the most visually striking, it does not necessarily mean that a yield response will occur. As a plant continues to develop and its roots explore more soil, starter fertilizer supplies progressively less of the total nutrients taken up, making nutrient supplies elsewhere in the soil profile more important. End of season yield responses depend on how quickly and to what extent a plant root system accesses these other supplies. Under conditions where root exploration is limited or slowed, yield responses are more likely. This holds true as well when soils are less fertile.

Many would argue that when striving to achieve consistently higher yields, a starter fertilization program should be seriously considered. Whether or not it fits a particular farm depends on many things beyond those strictly agronomic. However, starter fertilizer does provide some level of insurance against nutrient variability and adverse growing conditions and is a management practice with a rather extensive body of scientific studies supporting its use.

—TSM—

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Abbreviations: N = nitrogen; P = phosphorus; K = potassium.

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SOCIAL MEDIA IN AGRICULTURE

Traditionally, agricultural information exchange has been dominated by industrial media such as newspapers, television, and magazines. In recent years, however, technology awareness and computer literacy are increasing across all demographics and various forms of social media are being used more and more by people looking for news, education, and other information related to agriculture. Social media can be defined as internet-based applications that allow the creation and exchange of user-generated content. It is the blending of technology and social interaction that creates value in these types of media.

Education and outreach efforts by industry and university extension personnel have often been identified as valuable or successful based on the face-to-face interaction with clientele. Dr. John Fulton, a precision agriculture extension specialist at Auburn University, sees social media as a means of enriching his efforts, not a hindrance to them. Dr. Fulton says: "If I restrict dialogue only to a one-on-one conversation, then only that person can take advantage of it." By sharing the information exchanged during one face-to-face encounter through his social media network, Dr. Fulton has the opportunity to serve potentially millions of other growers asking the same questions or facing similar challenges. Social media also provides growers a quick and easy way to build relationships and to interact with people in agriculture that they might never have connected with otherwise.

There are many different forms of social media, including web, social, and micro blogs (a blend of the term *web log*), podcasts, video, and other file sharing sites. Some specific applications that the International Plant Nutrition Institute (IPNI) currently uses include YouTube and Twitter. YouTube is a video-sharing website where users can upload and view videos. IPNI has created a "channel" on the YouTube site where all of our posted videos are collected. The web address is **http://www.youtube.com/PlantNutritionInst**. You do not need an account to view videos, only to post your own. All of the videos are also available through the IPNI website, **www.ipni.net/video**. The value of using YouTube is that viewers with no knowledge of IPNI can find the videos and be directed back to the IPNI website to become familiar with the Institute. For example, only 23% of the viewers of one of our posted videos, "The Right Way to Grow Wheat", were referred from the IPNI website. The majority of viewers find our videos by using a YouTube search or by viewing related videos. YouTube also facilitates downloads of our videos to mobile devices, such as smart phones and iPads, which have become a more frequent means of viewing our material over the past six months.

Twitter is a microblogging service that allows users to post and read text-based messages of up to 140 characters. The messages or "tweets" are usually visible to the public. However, authors may restrict delivery to only their subscribers or "followers". Users can send or receive messages via the Twitter website or mobile devices. The IPNI twitter account can be accessed at **www.twitter.com/PlantNutrition**. A tweet from IPNI will typically be a short statement about a new posting on the website and a link to the full article or news item, such as:

> **Better Crops with Plant Food (2010, No. 3) is loaded with articles that focus on spatial variability. #ag http://info.ipni.net/Y53U6**

The value of using Twitter to call attention to these postings is that it draws immediate visibility to an item that might not be seen otherwise by people who don't frequently visit the website. Another advantage is that a user can "retweet" any message to their list of followers, broadening the distribution beyond IPNI subscribers. An additional way to increase the number of viewers is by appending the message with a "hashtag". In the case of IPNI tweets, the hashtag is **#ag**. This link makes the tweets searchable to others within the agriculture community who might be following related users but are not familiar with IPNI.

Social media provide a quick and responsive network for people involved in agriculture to gather and exchange information. It allows immediate dissemination of important emerging issues and the sharing of positive information among producers and consumers of agricultural products. IPNI is committed to providing science-based plant nutrition and fertilizer use information to industry, farmers, agricultural and environmental leaders, scientists, and public policy makers. So, follow us on **Twitter @PlantNutrition** to receive all the latest updates.

—SBP—

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TRACKING NITROGEN USE EFFICIENCY ON YOUR FARM: TIPS FOR TRIUMPH

If you were asked how good your N management (source, rate, timing, and place of application) was for the crop(s) on each of your fields this past year, how would you answer? Was N managed at the optimum, most economically rewarding rate? Unless on-farm replicated N management comparisons were made, it would probably just be a guessing game for most of us.

The effectiveness of a given N management program, and the efficiency with which the crop utilizes the applied N, will vary greatly with weather conditions, year in and year out. To try to be as efficient as possible, most farmers use local university research results to guide their initial management decisions, but make modifications based on their own field observations and experiences.

Unless we actively monitor the crop's N status during the growing season, we never really know how well nourished the crop is or was until harvest time. End-of-season crop assessments and documentation of yields on each field, in and of themselves, can provide important feedback on past decisions and help to influence future N management directions. But such measures are merely looks in the rear-view mirror.

Yet, the importance of those "after-the-fact" looks in the rear-view mirror should not be downplayed. When crop yield is evaluated per unit of N applied (e.g. bushels, hundred weight, tons, or bales per pound of N applied per acre), and those values are tracked for each field each year, over a period of years, a great deal can be learned. There are other ways to measure crop N use efficiency, but these calculated values serve as perhaps the most practical field-level measure of N use efficiency. An upward trend in the calculated values over time implies that N use efficiency may be improving. If the trend in values of yield per unit of applied N is flat or declining over time, then closer scrutiny of the N management program, and possibly a detailed assessment of the entire crop management system, is called for.

To begin moving your N management program toward greater effectiveness and efficiency, and to help improve your bottom line while protecting the environment from controllable N losses, start with some simple calculations for each field on your farm. Divide crop yield by the applied N rate, and plot the values for each year, on each field. The results may reveal your prowess as a top-notch N manager … or they could serve as important indicators of the need for a N management tune-up. Either way, tracking N use efficiency for each field can be just as important as monitoring the milking performance of a dairy cow. Without performance records, it is difficult to make critical management decisions that are essential to remaining competitive in the farming business.

—CSS—

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Abbreviation: N = nitrogen.

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SILAGE PRODUCTION AND FERTILIZATION

Ensilage or ensiling is a process of preserving forage for later use as animal feed. Silage can be defined as any plant material that has undergone fermentation or “pickling” in a silo. And a silo is any storage structure in which green, moist forage is preserved. Silage production is important in parts of the Great Plains, especially where there are significant numbers of animals in feeding operations such as dairies and feedlots.

There are several advantages of silage compared to hay and other forage conservation systems. These advantages include less field and harvest losses, many crop options, mechanization of harvesting, storage and feeding, less likelihood of weather damage during harvesting, relatively low loss of nutrients with proper ensilage, and silage can be used in many livestock feeding programs. The disadvantages of silage include its bulkiness in handling and storage, it requires additional equipment and structures for harvesting, storing, and feeding, high potential for loss if not stored properly, not readily marketable off-farm, and silage must be fed soon after removal from the silo to minimize spoilage.

The major factors affecting silage quality are the type of crop, stage of maturity, moisture content, and length of chop. Within forage species the stage of maturity has the greatest effect on quality. The optimal moisture content depends on the crop and type of silo used, but is generally around 65 to 70%. Material ensiled below 50% moisture is usually called haylage. Length of chop is a factor since it affects air exclusion in the silo. Fine chopping and packing help ensure proper fermentation.

Many crops, including grasses and legumes, can be preserved through ensilage. The most common and perhaps the best adapted is corn. It is high energy and results in good animal performance. Sorghum (grain and forage) is a popular silage crop in some areas. Alfalfa is also used for silage, but the process of ensilage is somewhat more difficult than with other common crops.

As in hay production, the harvest of a crop for silage results in the export of large quantities of nutrients from a field. For example, a 30-ton harvest of corn silage will remove about 250 lb N, 110 lb P_2O_5, and 250 lb K_2O. This is one of the most important points to keep in mind when designing fertility programs for silage crops.

Nitrogen fertilization can affect fermentation of some crops by decreasing the concentration of soluble carbohydrates required to make high quality silage. This is particularly true with cool season grasses since they tend to be relatively low in available carbohydrates to begin with. On the other hand, corn is relatively high in soluble carbohydrates, so N fertilization is not a concern from this standpoint.

Phosphorus and K fertilization of crops for silage should be based on soil test information and experience. Nutrient removal data should also be considered. Phosphorus and K can be rapidly exported and depleted from soils under silage production if adequate amounts of these nutrients are not applied.

There are many excellent sources of information on the topic of fertilization and ensiling of forages. Among these sources is a practical handbook entitled *Southern Forages* (available through the International Plant Nutrition Institute, **www.ipni.net**). Other good sources are available through land grant universities and local county extension offices.

—WMS—

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Abbreviation: N = nitrogen; K = potassium.