The Analysis

Agronomic Information From

Spectrum Analytic Inc.

Winter 2013

Merry Christmas & Happy New Year!

Mother Nature once again gave us some surprises this year with early snow fall and new December low temperatures. But overall we have a lot to be thankful for this year with a great growing season in most areas of the country as well as a bountiful yield once again.

We want to take the opportunity to introduce everyone to our newest employee at Spectrum Analytic. Amanda Martin joined our staff earlier this year. Amanda will be filling an agronomist position when Scott goes into full retirement in the future.

We continue to offer the Solvita soil test as an optional analysis to evaluate soil health as related to microbial activity. Retailer and grower interest continues to grow. This test was first introduced to the market place in late winter of 2010. There is limited research regarding calibration of the test for making nitrogen recommendations; however Woods End Lab and several university soil scientists are doing research to calibrate the test and make it more useful for the agricultural market. Research projects continue on the test so that information can be better applied to evaluate soil health.

All the employees at Spectrum Analytic wish you and your employees and their families a Blessed and Merry Christmas. We hope that everyone enjoys the holidays together with friends and family and that everyone travels safely. In 2014 we will be facing new challenges once again, take these challenges and convert them into an opportunity. May the New Year be successful to you and all your business ventures.

Who To Contact...

Agronomy .... Bill Urbanowicz
Amanda Martin
Scott Anderson
Chief Chemist .... Vernon Pabst
Sales/Marketing .... Mike Hall
Office & Billing .... Donna Scott
Fertilizer & Feed .... Vernon Pabst
Computer .... Wayland Reid
Lab Technicians .... Randy Johnson
Jim Armstrong
Wayne Jinks
Cynthia Cook
Justin Stich
Sue Sunderhaus

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A Look at Micronutrient Uptake and Storage in Corn

By Amanda Martin

Corn production has seen several changes in cultivar, fertilizer inputs, and management practices over the years. A lot of research focus has been on macronutrients (N, P, and K) due to the higher amount taken up by crops. For example, Dr. Fred Below from the University of Illinois observed that new corn rootworm resistant corn hybrids tend to take up more potassium than conventional varieties (*Crop Life*, October 2013).

Recently, a study from Purdue University investigated micronutrient (Zn, Cu, Fe, and Mn) uptake and allocation in modern corn hybrids under the following conditions 1) three different rates of nitrogen fertilizer and 2) different plant densities. This was a two part experiment conducted by Dr. Ignacio Ciampitti and Dr. Tony Vyn.

The findings from the first half of the study indicated that high yielding, modern corn hybrids take up not only more nitrogen from soil but more micronutrients such as zinc, iron, manganese and copper. Nitrogen fertilizer rates also influence how much of these nutrients are stored in the grain at harvest. Growers may need to use fertilizers to meet the increased micronutrient requirements of hybrid corn in high-yield systems, especially if soil nutrient levels are too low.

According to Dr. Vyn, Purdue professor of agronomy and co-author, "This study raises the question of whether we need to pay more attention to micronutrients in fertilizer management," He continues by stating, "In high-yield systems, it's not just that corn requires more macronutrients like nitrogen and phosphorus - which is what farmers normally think about - more micronutrients are needed as well. If you have soil that is deficient in micronutrients, you could be limiting your yields."

"Though micronutrients are essential for optimum plant growth and reproductive development, current management practices rarely take them into account, as growers often assume that soil nutrient concentrations for these nutrients are adequate. But in modern crop production systems, deficiencies could occur", Vyn said.

"For many years, we didn't have to worry about micronutrients," he said. "But if you're in a cash crop situation where you're producing bigger plants and more grain, you are exporting more micronutrients away from the field at harvest. If you're not replacing them, the soil is going to be depleted over time." In order to see if micronutrient applications are necessary for a fertilizer program in a given crop year or if a grower is planning on using modern hybrids, soil testing for micronutrients using an S2 or S3 package is the best way to assess if micronutrients are in the good range for that crop year in the rotation.

"Soil factors such as pH and moisture can also influence micronutrient availability", said Ignacio Ciampitti, co-author of the study and assistant professor at Kansas State University. Additional factors that affect micronutrient uptake include: competition with other micronutrients and organic matter content.

"Nutrient availability is more complex than soil nutrient concentrations," Ciampitti said. "Nutrient availability is also related to the plant's ability to take up each nutrient at the soil root interface".

In the second part of a study observing how modern corn hybrids (post-1990) absorb and allocate nutrients under contemporary management practices, Vyn and Ciampitti measured how simultaneous increases in the number of plants per acre and nitrogen rates affected the concentration of zinc, copper, iron and manganese in two hybrids of corn.

Vyn indicates that the influence of plant density on the uptake of micronutrients was relatively minor, even at high crowding levels, in that higher plant density resulted in similar yields as medium and low densities. But as nitrogen rates increased, yields rose and corn plants took up a substantially greater amount of micronutrients and allocated more micronutrients to the ears.

"From a human nutrition viewpoint, there's always a concern that increasing yields will dilute the nutritional quality of corn," Vyn said. "But as long as soil concentrations of nutrients are sufficient, higher yields tend to mean more micronutrients are concentrated in the grain, not less."

But higher corn yields mean more micronutrients leave the field at harvest. This is due to an increase in plant biomass in the modern hybrids.

Typically, "Growers are not used to thinking about how much zinc leaves the field when they harvest grain corn," Vyn said. "But that's part of the management equation that has to be considered." For example, at high plant density (42,000 plants per acre) and high nitrogen rates (200 pounds per acre), 58 percent of zinc taken up by corn hybrids was removed in the grain, compared with 31 percent of copper, 18 percent of iron and 15 percent of manganese.

Both professors observed differences regarding when micronutrients are absorbed and where they are stored in the corn plant. They found that zinc is taken up throughout the season and is primarily stored in the stems during the vegetative stage, while iron is allocated to the leaves. Copper and manganese are distributed to both leaves and stems and are taken up mostly before the flowering period.

To prevent deficiencies, Vyn suggests growers add zinc to bulk fertilizer with phosphorus- which has a similar uptake pattern - or put it in a starter, while manganese can be supplied in a foliar application where necessary. Growers usually can rely on soil for sufficient levels of iron and copper, he said.

Conclusions from this study point toward further research that will concentrate on developing estimates for micronutrient requirements to help inform growers which kinds of fertilizers to apply and when.

"There's no question that when you have more biomass and higher grain yields, you require more of certain micronutrients," Vyn said. "It's something to be aware of."

Routine plant tissue testing along with soil testing is the best way to monitor micronutrient levels prior to the nutrients maximum uptake. Tissue testing is also a way to assess crop response to post emergence nutrient applications to improve fertility programs to accommodate the newer hybrids and achieve maximum yield.

Meet Amanda

Spectrum Analytic has recently hired Amanda Martin as a new team member to help serve our clients. Amanda, a Wisconsin native, joined the Spectrum team in March and was hired to be an Agronomist under the guidance of Bill Urbanowicz and Scott Anderson. Her educational background includes a B.S. in Environmental Science from Iowa State University and a M.S. in Plant and Soil Science from the University of Kentucky. Her master's involved an extension research project evaluating the fertility status of potassium in Kentucky soils. She has spent the last two years running the Soybean Verification Program for the University of Kentucky where she worked with both farmers and retailers scouting soybean fields across western Kentucky. "As the new girl in town, working at Spectrum Analytic, has been a great learning experience thanks to great training under Bill and Scott. It is a great facility that is truly geared to making life easier for our customers. I cannot wait to continue to learn and interact with more customers in the future."

Lessons from plant analysis in 2013

By Bill Urbanowicz

We analyzed thousands of plant tissue samples this year and the interest and amount of samples taken each year in the Midwest continues to grow. The survey listed here tells quite a story about the nutrient situation of our crops. In looking at the data, keep in mind that this is a biased survey. That's because most people don't send us samples of healthy appearing or acting plants. They more often are trying to find out why the crop is not performing as they would like or expect. Having said that, each year more customers are taking the advice of their crop consultants, fertilizer dealers and our lab and are sampling crops that they thought were "normal". As the following table shows, there were a lot of hungry crops in 2013.

We have highlighted the values that indicate more than 33% of that crops nutrients were low, but that is an arbitrary choice. No crop producer would want a third of his crop to be nutrient deficient, so take notice of some of the other results as well as the highlighted ones.

Many of these samples had accompanying soil test results, the fertilizer program, and recent weather conditions. From this information it was apparent that the main reasons for these results were:

- Acid Soils
- Weak Soil Tests
- Weak Fertilizer Programs
- Annually Cash-Rented Land (probably)

K continues to be the main nutrient that reports the most samples below normal. The use of calcitic lime may be a reason for the amazing number of low Mg levels. However, a lot of growers have to pay a little more for dolomitic lime and they apparently are not willing to use this inexpensive source of Mg. Of course this is a "pay me now, or pay me later" situation and they paid later with an Mg deficient crop. Another reason for a few of the low Mg levels is that some growers have gotten their soil K:Mg ratios out of balance. Grasses (especially corn) like a soil K:Mg ratio of about 1:1. If the soil K:Mg ratio is higher than about 1.5:1 (in ppm or lb/ac, not saturation), nearly all crops will have Mg problems... again, regardless of how high the soil Mg level is. This is because the excess K will prevent adequate uptake of Mg.

After emphasizing the problems of excess soil K, we see that low plant K uptake is probably the first most widespread problem. For a long time now, we have watched as the K fertility of farmland in general has deteriorated. This was happening before the price of potash spiked, but based on our experiences, that spike in prices appears to have further weakened potash use and aggravated the slide in soil K tests. As with lime, we suspect that annually cash-rented land is one of the main reasons for weak fertility programs in general.

Micronutrient use has increased the past several years and we do not see as many low micronutrient levels that we saw 5+ years ago. In 2013, we did see some crops with Cu levels 16%+ below normal as well as some marginal Zn levels in wheat, apples and blueberries.

Space doesn't permit an in-depth discussion of all of the crops and their nutrient trends, but this information should put everyone on notice that there are significant areas for improved yields through proper fertilizer use.

Crop	Samples Below Normal										
	N	**P**	**K**	**Ca**	**Mg**	**S**	**B**	**Cu**	**Fe**	**Mn**	**Zn**
Corn	15%	8%	19%	2%	32%	5%	0%	2%	0%	3%	9%
Soybeans	***42%***	13%	***35%***	3%	11%	2%	0%	16%	0%	0%	0%
Wheat	20%	14%	14%	0%	***47%***	4%	3%	16%	0%	4%	***35%***
Alfalfa	4%	0%	***46%***	0%	***51%***	6%	3%	1%	0%	1%	0%
Apples*	6%	2%	***59%***	***58%***	12%	0%	1%	16%	0%	2%	26%
Grapes	17%	0%	***37%***	30%	12%	32%	10%	20%	1%	0%	1%
Blueberry	23%	3%	11%	3%	23%	0%	9%	***46%***	14%	3%	31%

Bold Values Are More Than 33% Below Normal
**Apple Ca uptake is not necessarily related to soil Ca*

Crop Nutrition Problems Can Become Pest Problems

Dr. Robert Mikkelsen, Western North America Director, IPNI,

We are familiar with the concept of preventative medicine, where health problems are avoided by good practices instead of curing sickness after they occur. This same concept applies to damage caused to crops by plant diseases and pests when adequate and balanced nutrition is lacking.

Each nutrient in plants has unique and specific functions that operate in an intricate balance of physiological reactions. A deficiency of a single nutrient will result in stress that impairs healthy plant growth. Until the symptoms of deficiency stress become visible, the hidden roles of proper nutrition in maintaining plant health are too frequently overlooked.

New scientific studies are again confirming what farmers have known for many years about the link between plant health and nutrition. Healthy plants can generally withstand stress and attack better than plants that are already in poor condition. For example, recent work with corn has demonstrated the link between an adequate K supply and increased leaf thickness, stronger epidermal cells, and decreased leaf concentrations of sugars and amino acids. All of these factors lower the attractiveness of plants for pests, such a spider mites.

The link between adequate K and soybean aphids has also been recently reconfirmed. Research shows that K-deficient soybeans tend to transport more N-rich amino acids in the phloem, making them a favored target of stem-sucking aphids.

The link between plant nutrition and disease control generally falls into one of these categories where proper fertilization can:

Reduce pathogen activity: Proper mineral nutrition can slow or inhibit the germination and growth of a variety of plant pathogens in soil and in plant cells.

Modify the soil environment. The selection of a N source can temporarily modify the rhizosphere pH during critical periods between germination and seedling establishment. Likewise, the addition of elemental S is a common practice to acidify the root zone of some crops for disease control.

Increase plant resistance: Healthy plant tissues are less susceptible to infection. Proper nutrition can stimulate the production of physical and chemical defenses to cope with pathogens.

Increase tolerance to disease: Adequate nutrition can help plants compensate for disease damage and to sustain a high level of natural compounds that inhibit pathogen growth within plant tissue.

Facilitate disease escape: Plants that are adequately fertilized with boron (B) and zinc (Zn) have been shown to have fewer fungal spores that break dormancy on the roots, compared to deficient plants. A healthy photosynthetic capacity also allows for a quick growth response to a pathogen invasion.

Compensate for disease damage: An adequate supply of plant nutrients is closely linked with vigorous root growth and photosynthetic activity. These healthy plants can better tolerate increased disease burdens than plants stressed by nutrient deficiency.

Nutritional and environmental stresses often trigger greater pest and disease damage to crops. While proper fertilization does not eliminate the risk of pests and diseases, it provides an important degree of protection from many yield-robbing factors.

Effective disease and pest management through proper plant nutrition improves crop quality and contributes to provide a safe, abundant, and nutritious food supply.

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Mycorrhizae Fungi & How They Assist in Nutrient Absorption

Dr. Thomas L. Jensen, Northern Great Plains Director, IPNI

There is a lot more than just plants that live and grow in soil. Soil inhabiting organisms include a diversity of types and sizes. There are small burrowing mammals, insects, amphibians, and worms that can be seen with our eyes, and also a large diversity of tiny and microscopic biota including nematodes, bacteria, fungi and actinomycetes. All of these organisms work to breakup, disperse, incorporate into the ground and decompose plant residues. They also in many instances help to weather soil mineral components and less soluble precipitated compounds. All this activity results in the release of plant nutrients in mineral forms that plants can use to grow. The whole process of nutrients being used by plants, and then plant residues being decomposed in soil is a vital part of nutrient cycling in the environment.

The majority of the nutrients in soil, at any one time, are stored in forms that are unavailable to plants. At first this sounds less effective, but is in fact a necessary feature of soils so that nutrients are stored and released in a timely and adequate manner, but not so soluble that they would be easily leached out of soils. Plant roots exude chemicals that help to dissolve some of these more complex and less soluble compounds that contain plant nutrients. However, plants are not able to do this all on their own, and this is where other soil-inhabiting organisms, noted above, help out. One especially effective and beneficial group of microbes is a genus of fungi called Mycorrhizae (*M*). These fungi have the ability to grow into the roots of many plant species, while their fungal hyphae or branches grow into the soil matrix.

M fungi are beneficial to many important agronomic crop species in a couple of ways. They live symbiotically with the crops by accessing and supplying needed plant nutrients from the soil to their plant partner. The plant in turn shares photosynthetically produced sugars to the fungi as an energy source. The *M* fungi make nutrients accessible to crop plants by first effectively increasing the extent of the plant root system in soil by exploring portions of the soil that the roots would not grow into and touch. Secondly, they have the ability to dissolve low solubility compounds containing plant nutrients, that crop roots are less effective at doing. Because many plant nutrients have low mobility in soil, they diffuse slowly and for only a short distance, for example a few millimeters in a growing season, from an area of higher concenration to an area of lower concentration. It is very helpful to have the *M* hyphae assist in finding and acquiring needed nutrients. In these two ways they help supply nutrients to crops, especially less mobile phosphorus, potassium, and most micronutrients.

Management of cropping systems by choosing certain crop rotations and reduced tillage systems can help *M* fungi to be more effective. Even though in the original natural state many of the grassland soils of the Northern Great Plains contained a diverse group of *M* fungi species the use of intense tillage, summer fallowing, and predominately growing wheat, has drastically reduced the number of *M* fungi species surviving. The remaining species cannot supply needed plant nutrients as well compared to if more species would be present. However, by using conservation or no-till cropping, and a more diverse crop rotation including pulse crops such as lentils and field pea in rotation along with small grain cereal crops, it is possible to create soil conditions suitable to re-establish many beneficial *M* fungi species.

There is on-going research in the Northern Great Plains on how to bring back the beneficial influence of missing *M* fungi for growing crops. Research is being led by Dr. Chantal Hamel, Director of the Soil Microbiology Laboratory, Semiarid-Prairie Agricultural Research Centre, of Agriculture and Agri-Food Canada, Swift Current, SK. Dr. Hamel's research team is selecting beneficial missing species of the fungi, still present in natural grasslands, and reintroducing them into cropped soils. Part of the technique to achieve this is to successfully grow the needed species in sufficient quantity under controlled laboratory conditions, inoculate the seed of a compatible crop species, e.g. a pulse crop, and grow this crop in rotation with wheat. The use of no-till planting and cropping helps the reintroduced fungi to survive, as tillage itself is disruptive to established fungal hyphae in soils. Many of the so called "lost" species of *M* fungi will increase nutrient availability to crops, after reintroduction using less tillage, cessation of summer fallowing, and growing diverse crops in rotation.

The Facts About Phosphate Rock: Are We Running Out?

Dr. Robert Mikkelsen, Western North America Director, IPNI

Most of the phosphate rock that is mined from the earth goes towards making fertilizer for crop production. Every cell in plants and animals requires P to sustain itself and there is no substitute for it in nature.

During the past five years, there were several well-publicized reports suggesting the world phosphate rock supply was rapidly dwindling. In response, there was widespread concern about whether we were reaching our "peak" supply of phosphate rock and if fertilizer shortages are on the horizon.

Recently updated estimates report that the earth has at least 300 years of known phosphate rock reserves (recoverable with current technology) and 1400 years of phosphate rock resources (phosphate rock that may be recovered at some time in the future). These numbers fluctuate somewhat since companies do not intensively explore resources that will only be mined far in the future.

Phosphate fertilizer can be a significant cost for crop production and an important mineral for animals. However from a global perspective, phosphate is considered as a low-price commodity. One recent publication estimated that each person consumes an equivalent of 67 lb phosphate rock each year. This results in an annual consumption of about 9 lb P per person (or 0.4 oz. daily consumption), which is equivalent to 1.7 cents per day.

Phosphorus atoms do not disappear in a chemical sense, but they can be diluted in soil or water to the point where it is not economical to recover. Annual P losses to the sea by erosion and river discharge roughly balance the quantity of P that is mined. This shows that there is substantial room for improvement in efficiency. Implementing appropriate recovery and recycling of P from animal manure, crop residue, food waste, and human excreta would make a major step in this direction.

Efforts to improve P efficiency and build soil P concentrations to appropriate levels, serve to enhance its use. In developed countries with a history of adequate P fertilization, the need for high application rates diminishes over time. This contrasts with the situation in many developing countries where low soil P concentrations still require significant fertilizer inputs to overcome crop deficiencies.

Members of the public are encouraged to engage in debate over important issues, but there is a danger that oversimplification leads to incorrect conclusions. The case of looming P scarcity is an example where insufficient information led to a wrong conclusion. Somehow the incorrect notion still persists that there is an impending shortage of P and that limited fertilizer availability will soon lead to global food insecurity.

There may be a scarcity of many earth minerals some day, but the P supply will not be a concern for hundreds of years. However responsible stewardship of rock phosphate resources still requires a close examination of improving efficiency throughout the entire process, including mining, fertilizing crops, and implementing strategic waste recovery. Working together to improve P management will allow us to conserve this precious resource for future generations.

The Analysis is published as a service to agricultural dealers and crop consultants by Spectrum Analytic Inc.

If you have any questions or comments, please call 800-321-1562 or email info@spectrumanalytic.com

Bill Urbanowicz
Editor

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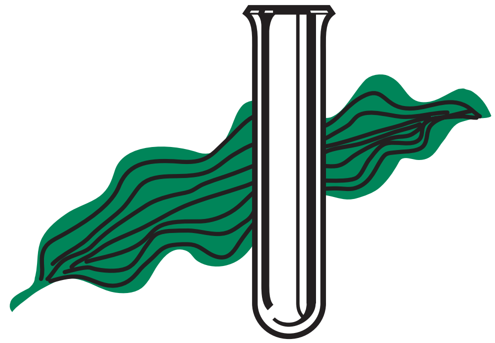

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Spectrum Analytic Inc.
1087 Jamison Road NW
Washington Court House, OH 43160

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