NUTRIAG ACADEMY

Advanced Learning

The Fruits of Our Labour
Storage and Colouring for Apples

Priming Your Potato Crop at Planting for High Yields
Promote the crops' potential before it starts battling yield robbing elements.

Manganese & Molybdenum
Role in improving Nitrogen utilization & fixation in soybeans

Zinc: The Essential Micronutrient
A closer look at it's role and process for uptake.

NutriAnalytics: Using Modern Statistical Tools
To Improve Tissue and Soil Sampling

Micronutrient coatings for granular blends
Uptake matters

NUTRIAG Innovators in the field

PUTTING KNOWLEDGE TO WORK

- Dr Chris Trobacher, PhD, CCA-ON
Director of Research and Communication

Welcome to the first edition of the NutriAg Academy Newsletter! The purpose of which is to continue our tradition of educating our partners in industry on current topics and trends in agriculture. Why the focus on education? We believe that knowledge is power; it boosts our confidence and can be the spark that motivates us to continue innovating. This newsletter goes together with our online learning platform NutriAg Academy, where our industry partners can register and work through informative modules on a variety of topics at their own pace. Visit NutriAg Academy at: **https://www.nutriag.com/nutriagacademy/** to register.

In this inaugural edition several members of our staff of agronomists, researchers, and scientists deliver you current information on topics ranging from apples and beans to nutrition and software.

Our Field Research Associate in Atlantic Canada, Lindsay Birch, highlights the role of calcium and phosphorus nutrition in producing a quality apple crop. Close attention to calcium nutrition can reduce physiological disorders and improve post-harvest storability of fruit, while phosphorus applications are associated with increased anthocyanin production to give beautiful red fruit.

Two of our area managers have contributed articles discussing the benefits of several key nutrients for potatoes and soybeans. Michelle Dyment reviews the success of in furrow applications of ZincMax and CalciMax in potato production in Atlantic Canada. Chad Mangan does a deep dive on nitrogen metabolism in soybeans with a focus on the role of two micronutrients: manganese, and molybdenum.

NutriAg's Technical Sales Rep in California, Chandler Wilson, takes a close look at zinc; how it behaves in the soil and inside the plant and why foliar applications of zinc can be a good decision.

Questions about which nutrients to apply, and when, are greatly simplified by our proprietary software platform, NutriAnalytics developed by our VP of Agronomy and Informatics, Sebastian Margarit. NutriAnalytics combines artificial intelligence tools with agricultural data to make evidence-based recommendations for your crop using soil and/or tissue test data.

My own contribution to this edition is an article discussing micronutrient coatings for granular fertilizer blends. Part of my time at NutriAg is spent on developing and testing new products. Our FertiCare line of coatings is one that I had the pleasure of working on that has made it to market and offers some practical advantages over the competition.

I hope you find this edition as informative and engaging to read as it was to put together. Best wishes for the 2022 season!

THE FRUITS OF OUR LABOUR

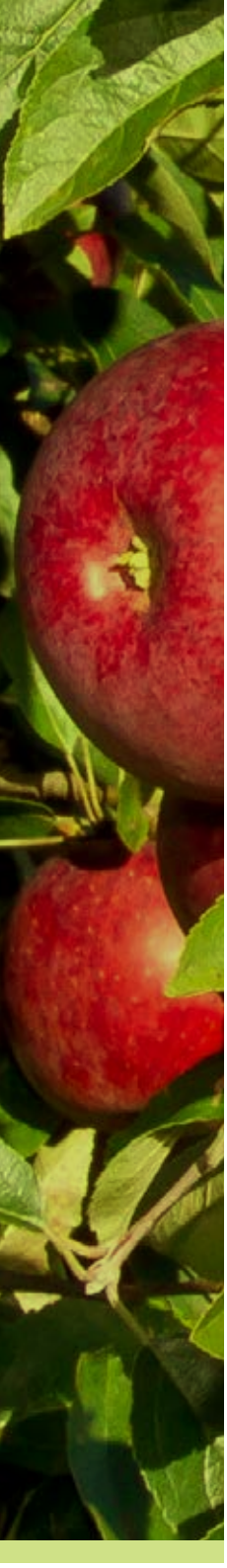
- Lindsay Birch,
Field Research Associate

In order to achieve high-quality fruit it is critical to achieve both the longevity of fruit in storage and an excellent fruit finish in order to entice a consumer to purchase the apples.

During the growing season different strategies and practices are used to manipulate a tree to produce a high-quality apple. This is achieved by better canopy management, thinning, integrated pest management, and fertility management.

Close attention to crop fertility is important to achieve high-quality fruit, and while many nutrients contribute to this achievement calcium and phosphorus play an instrumental role. Calcium is one of the most talked-about foliar nutrients for use during the growing season to increase fruit quality. Calcium is essential for membrane strength, cell wall structure, cell elongation, and cell division.

Without sufficient calcium, apple fruit can run into physiological disorders and early breakdown in storage. When calcium levels are sufficient the synthesis of ethylene is reduced which can delay the ageing of fruit in storage (Saure, 2005). It's also known that low calcium fruit in storage has a high level of respiration that decreases turgor (He et al., 2015; Tuteja and Mahajan, 2007). The aim is to ensure that the calcium is being absorbed into the fruit to avoid unmarketable fruit. Early in the season, calcium travels through the xylem vessels and into the developing fruit. As the fruit begins to expand during the growing season the inelastic xylem vessels rupture causing a disconnect



between the fruit and tree which reduces further calcium delivery into the fruit. Some cultivars have more extended xylem vessels longevity than other cultivars. Think of how bitter pit in the cultivar "Gala" is rare, whilst it frequently occurs on "Honeycrisp". With the xylem out of order later in the growing season, and because calcium has poor mobility in the phloem, foliar applications of calcium are essential to keep sufficient calcium levels in the fruit.

Besides storability, calcium helps increase the intensity of colour in fruits.

Although the actual mechanism is not fully understood, it is hypothesized that fruit that has accumulated a higher content of calcium have enhanced fruit colour and higher external fruit quality (Larrigaudiere et al, 1996). Like calcium, phosphorus has had a similar positive correlation with fruit colour and firmness in apples.

Phosphorus is an essential structural element found in DNA, RNA, and cell membranes. Phosphorus is taken up in the form of orthophosphate, a small, plant-available molecule. In a study looking at a phosphorus and calcium foliar treatment, there was an increase in total and individual anthocyanins (Stampar, 2015). Anthocyanins are water-soluble flavonoids that give a red pigment as anthocyanin granules accumulate in the skin and result in a red fruit finish on the apples (Bae and Kim, 2006). Our own trials using a phosphorus and calcium product (TruPhos Calcium at 2 L/ac) show a similar trend. Foliar applications were made twice at 31 and 14 days prior to harvest and resulted in a 4.9% increase in red-coloured apples, allowing more fruit to be sold loose for a premium price.

Monitoring a tree's nutrient status with special attention to calcium and phosphorus can ensure that timely applications of these nutrients are done. This will allow for uptake and/or translocation of these essential nutrients to where they are needed in the plant and will benefit the tree and the fruit. Soil tests, in-season tissue collections, and finished fruit samples can all aid decisions about rates and nutrients required for your apple trees to grow high quality, marketable fruit.

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PRIMING YOUR POTATO CROP AT PLANTING FOR HIGH YIELDS

- Michelle Dyment,
Area Manager – PEI & NS

The day your potato crop goes into the ground it has the maximum potential to reach the highest yield possible. Why not do everything you can to promote the crops' potential before it starts battling yield robbing elements?

NutriAg has developed an in-furrow liquid fertilizer portion of the potato program to do just that. Our basic in-furrow program consists of CalciMax (8% Ca, 0.5% B) @ 3 L/ac & ZincMax (10.2% Zn, 0.5% B) @ 1 L/ac which are compatible to tank mix with many of the pesticides that farmers are already applying in-furrow.

CalciMax was targeted as an in-furrow application because calcium is one of the nutrients that cannot successfully be applied in-season to benefit the tubers/roots due to calcium being immobile in the plant. The addition of calcium helps the plant deal with stress, especially heat stress, as well as size tubers. Actively growing cells contain high concentrations of calcium. When a calcium deficiency is present it can restrict root growth which can lead to many other problems in potato production. Even when applied on soils where the soil tests do not indicate calcium is deficient, we are still observing yield advantages. This can be attributed to the nutrient being present in the root zone, in a plant available form when there is active root growth and uptake.

ZincMax is also included in the in-furrow application due to the often low levels of zinc that are commonly observed in petiole results. A common practice is to add granular zinc to

fertilizer blends as well as foliar zinc applications. We believe that even though we were seeing benefits with foliar ZincMax being applied together with the first two fungicide sprays, the plant would benefit by receiving zinc even earlier in its lifecycle when the plant is actively growing.

Zinc stimulates plant growth as well as stabilizes the structure of cell membranes, which helps to protect against stress-induced damage.

Zinc deficiency in a field is hard to identify because this is often a hidden hunger. Zinc deficiency results in smaller leaves on the plant, and this is hard to see when you have nothing to compare it to.

We have extensively researched this portion of our potato program with an average total yield response of 11.6 cwt/ac, which currently translates to a return of investment of approximately $115/acre. The higher yields are attributed to having a healthier plant in season which ultimately allows for more tuber bulking to occur. When CalciMax & ZincMax are applied in unison we are also seeing an increased tuber number. The in-furrow program is not causing the plants to set more tubers but it helps to prevent the plants from aborting tubers in-season during a period of stress (heat etc.). Along with the higher yields, we are also observing faster row closure, which can be attributed to the larger leaf area due to the plants not being deficient in zinc. Row closure is an important milestone we like to reach in the field. It means that the plant has lots of leaf area present for photosynthesis to occur for carbohydrate production and it also locks the moisture into the soil to help during periods of drought.

An in-furrow program for your potato crop is a great first step and an investment towards your high yield goals!

MANGANESE & MOLYBDENUM

ROLE IN IMPROVING NITROGEN UTILIZATION & FIXATION IN SOYBEANS

- Chad Mangan,
Area Manager – NorthEast, Canada and USA

Soybean plants need to accumulate roughly 4-5 pounds of Nitrogen per acre for every bushel of grain produced.

Nitrogen is one of the main nutrients required by plants for optimal growth and grain production. Legumes, such as soybeans, can access atmospheric nitrogen through a symbiotic relationship with nitrogen-fixing bacteroids that reside in root nodules. Soybean plants need to accumulate roughly 4-5 pounds of Nitrogen per acre for every bushel of grain produced. Ensuring nitrogen is taken up and utilized by the plant efficiently is paramount for maximum yields. Some key micronutrients such as Manganese and Molybdenum also play large roles in nitrogen fixation and utlilization in soybeans.

Manganese has several very important roles in the plant, including functioning as an activator or co-factor of at least 35 enzymes. Manganese is part of the structure of an important antioxidant (superoxide dismutase) that protects plant cells by deactivating free radicals, which can destroy plant tissue. Manganese also plays vital roles in photosynthesis, as a structural component of the photosystem II water-splitting protein.

During nitrogen fixation in the plant, ureides known as allantoin and allantoic acid are produced. These are the long-distance transport forms of nitrogen that move from the

nodules up to the plant shoots and leaves. Manganese is imperative for proper ureide function as it is directly related to the enzyme that facilitates these reactions. If the plant has low levels of manganese, nitrogen can be transported out of the leaves/shoots via the phloem back down to the root nodules. This can cause a build up of nitrogen in the nodules thus lowering respiration and hindering further fixation.

Manganese can be deficient in soils that are cold where microbial activity is low, under dry soil conditions, in sandy soils or high organic matter soils (especially peat and muck), and in soils with high pH. When deficient, manganese can be supplied by fertilizer in several forms, by foliar and soil-applied methods. Because plants typically require low amounts of Manganese, foliar applying a plant available form when the plant needs it most is ideal.

Molydenum is another micronutrient that is essential for nitrogen utilization in the soybean plant. One of Molybdenum's primary functions is in the nitrate reduction enzyme system in which nitrate molecules are converted to the amino form. This is an early critical step in the formation of proteins which are necessary for plant growth. Because the nitrogen-fixing bacteria in the soybean nodules require molybdenum, an inadequate supply will cause soybeans to nodulate improperly and show nitrogen deficiency symptoms. Access to molybdenum by the rhizobia is primarily mediated by active mobilization via the plant's vascular system, therefore we have seen lots of evidence demonstrating the effectiveness of foliar or in-furrow, on-seed applications of molybdenum on soybeans.

Molydenum is a unique micronutrient in that it is not only needed in very small concentrations for plant growth, but that's it one of the least abundant nutrients found in the earth's crust. It is also one of the only nutrients that is more available in more alkaline or higher pH soils.

In summary, nitrogen uptake and utilization in soybeans can be directly impacted by the plants access to micronutrients like manganese and molybdenum.

As Liebig's Law of the minimum states, plant growth is dictated not by total resources available but by the scarcest resource or limiting factor.

To maximize soybean yields, not only do we need to consider adequate levels of available macronutrients like nitrogen, but also some of the "just as important" micronutrients like manganese and molybdenum. Feel free to reach out to your local NutriAg representative for the best product containing either micronutrient for your soybean crop.

ZINC: THE ESSENTIAL MICRONUTRIENT

- Chandler Wilson,
Technical Sales Rep, California

Zinc is classified as a plant essential nutrient. It is given the category of a micronutrient as well, which means it is required by the plants but just in smaller quantities compared to macronutrients like N, P, and K. Zinc is a cation with a "2+" charge so it binds easily to the negative charges on soil colloids.

Plants can struggle to take up soil applied zinc for several reasons. Zinc has low mobility in the soil and moves mostly through diffusion. Diffusion is defined as a nutrient moving from an area of high concentration to an area of low concentration. Zinc is also taken up by root interception; when the root grows and directly contacts the nutrient for uptake. Within the plant, zinc has "moderate" mobility. Once zinc has been taken up by the roots, the plant will translocate that zinc to where it is needed in the plant (i.e., fruit, leaf, etc.). The zinc however will generally stay where it has been translocated to. If zinc is applied to the foliage of the plant, then the zinc will be taken up and generally stay where it was applied. The one exception to this is that when a plant is deficient in zinc. The plant can sacrifice some leaves and re-translocate that zinc to another part of the plant. Even though that is a great phenomenon, having a plant deficient in any plant essential nutrient will result in a decrease in yield potential.

Applications of phosphorus and calcium can inhibit the uptake of zinc, whereas zinc can inhibit the uptake of iron. At an ideal soil pH (around 6.5), zinc is naturally low in availability.

As the soil becomes more acidic, zinc tends to become more available in the soil. If the soil pH becomes too acidic, other nutrients will start to become very problematic with regards to uptake.

Deficiency symptoms of zinc include stunted plants and small leaves, short internodes (which leads to rosetting), and/or interveinal chlorosis on young leaves. The deficiency symptoms will always show on young leaves and tissues first.

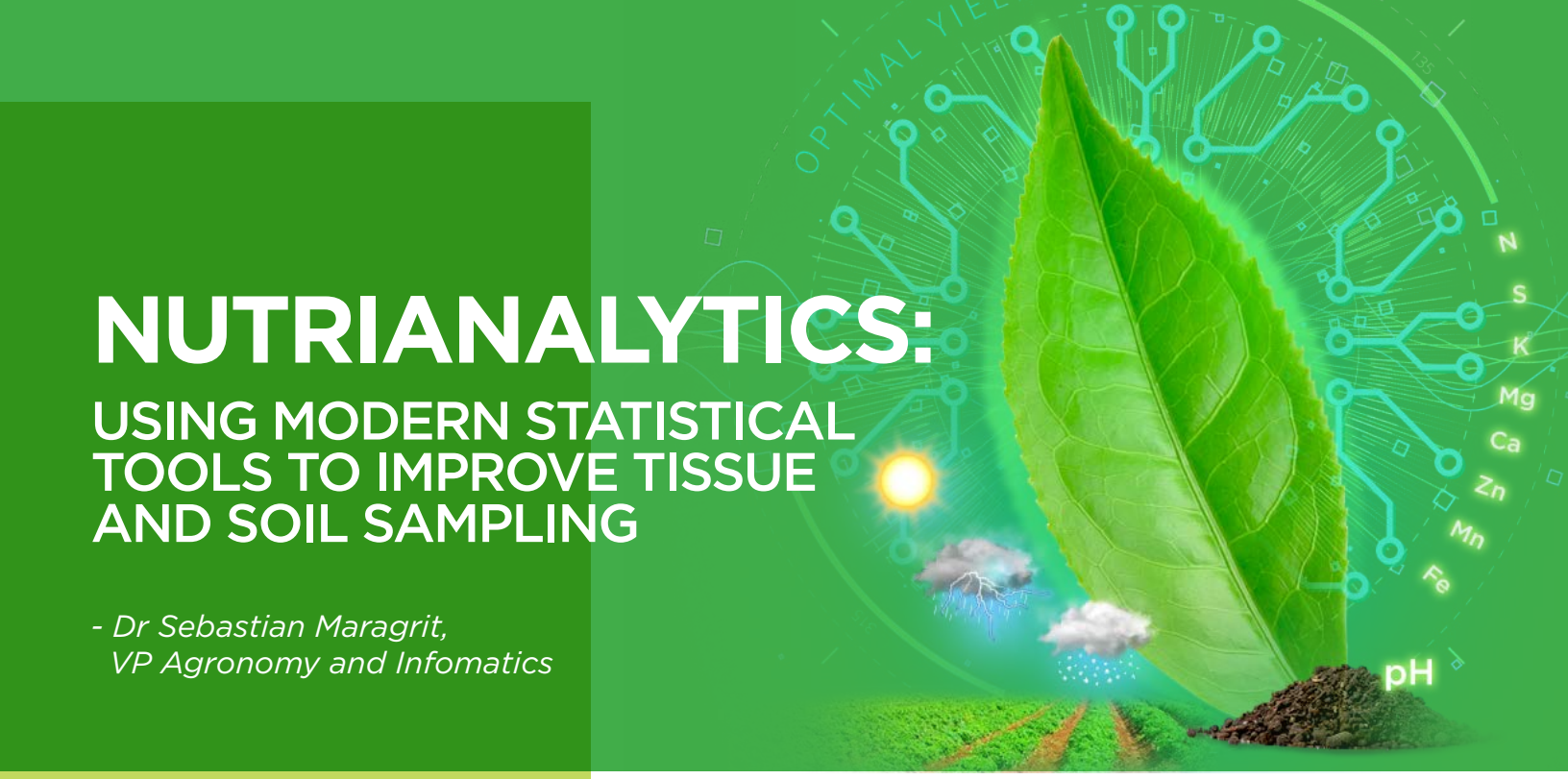
Zinc is critical for the several processes in plants. Zinc is bound by proteins associated with DNA and RNA and allows cells to produce the proteins required for proper meristem function and growth. Zinc is also involved in the antioxidant system used for abiotic stress tolerance. Zinc is found in many enzymes that help plants detoxify damaging molecules that accumulate under stressful conditions. This prevents the degradation of important growth hormones like auxins and keeps membranes functioning properly.

In California, we struggle with zinc availability and uptake due to alkaline soils. In addition, our soils are often high in calcium which is antagonistic to zinc uptake. Foliar applied zinc is very common to achieve adequate levels of zinc for crops and avoids issues with soil-applications. Soil-applied zinc is also common, but growers need to choose an appropriate product to prevent tie up in the soil. It is crucial to apply zinc throughout the season since zinc doesn't translocate in the plant well. As the crop continues to grow new tissues it will need a steady supply of zinc to drive various plant processes. Please reach out to your local NutriAg representative for information regarding which product containing zinc will fit best into your program.

NUTRIANALYTICS:

USING MODERN STATISTICAL TOOLS TO IMPROVE TISSUE AND SOIL SAMPLING

- Dr Sebastian Maragrit,
VP Agronomy and Infomatics



Soil and tissue sampling are fundamental methods for determining crop nutrient sufficiency and optimization. Farmers use soil samples in order to determine the appropriate fertilization strategies for a given crop however where do these recommendations come from?

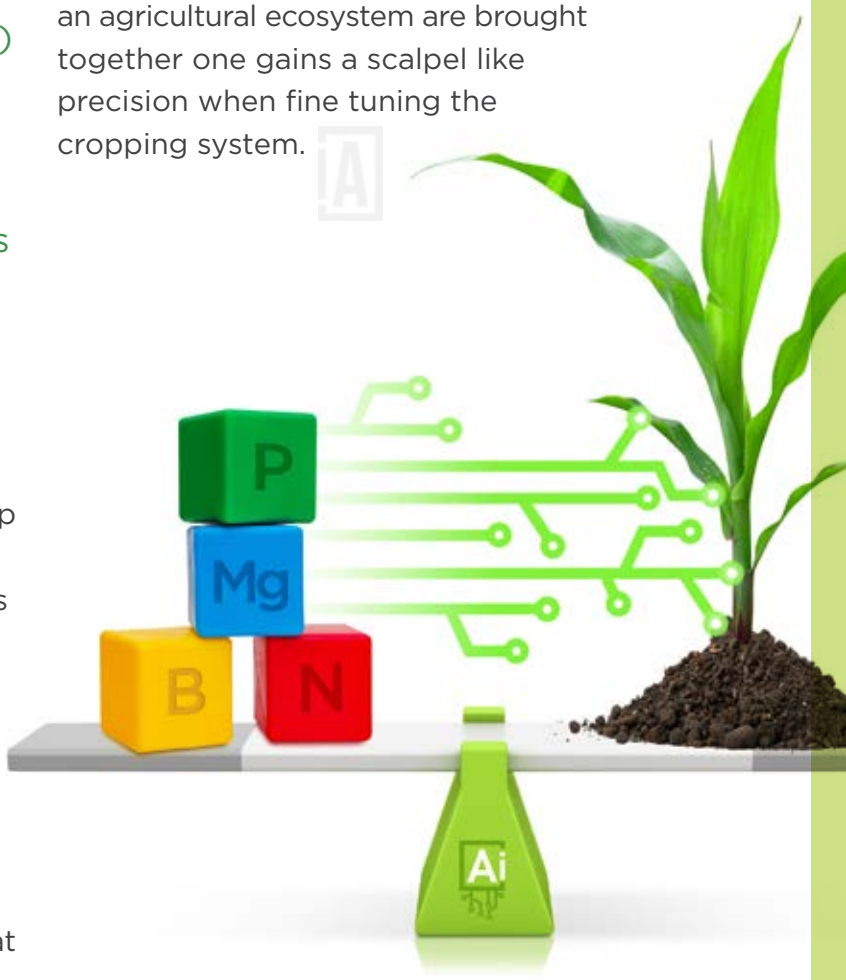
In most cases critical values were established decades ago with values associated with crop yields that are no longer relevant to producers. As modern tools for big data collection and interpretation have improved, so can our understanding of the nutrient profiles of crops. Data and information is useless without a trained eye for agriculture. Our data scientists are also agronomists and farmers which ensures they will NutriAnalytics uses modern artificial intelligence tools to explore and visualize the data from our agricultural ecosystems. We explore the interaction between nutrients like no other system can by combining the entire plant nutrient complex (rather than single nutrients alone) with the final yield and quality outcomes for a given crop. We are able to identify historical trends whereby improved yields and quality were attainable by improving macro nutrient use efficiency with the application of secondary and micro nutrient foliar interventions. NutriAnalytics can confidently classify the yield outcomes of various fields within a cropping region and identify fields where yield potential is significantly dimished due to a nutrient imbalance.

The artificial intelligence tools developed by NutriAnalytics can make decisions about fertilizer use much easier.

We can identify which nutrient(s) will give the biggest response on the crop by comparing the multi-nutrient complex with historical data and yields across many crops worldwide.

Local regional information improves the resolution of the grower's samples but also leverages nutrient interactions/trends that exist across the crop worldwide. Third party validation testing on high value vegetable crops have shown promising statistically significant yield responses ranging from 5-20% which showed returns on investments ranging from 3-8 fold.

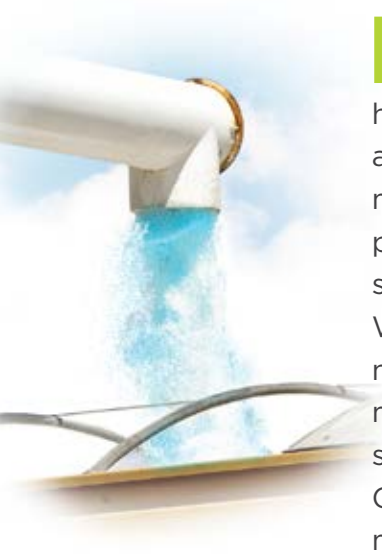
Cultural information in one cropping system can make it difficult to compare apples to apples when looking at soil and tissue testing. NutriAnalytics leverages modern statistical tools to parse apart the data in order to correct for things such as region, cultivar, density, weather etc. This improves the resolution of your view on the balance or imbalance of nutrients in your crop. When these major components of an agricultural ecosystem are brought together one gains a scalpel like precision when fine tuning the cropping system.



MICRONUTRIENT COATINGS FOR GRANULAR BLENDS – UPTAKE MATTERS

- Dr Chris Trobacher, PhD, CCA-ON
Director of Research and Communication

Micronutrients such as zinc, boron, copper, and manganese are the less understood components of a cropping system but are just as essential as the primary and secondary macronutrients (N, P, K, Mg, Ca, and S).



Both soil pH and temperature have a large impact on micronutrient availability and, in general, most micronutrients are less available to plants as soil pH increases and when soil temperatures are low in spring. Where a soil is lacking a given micronutrient, or a crop cannot access the micronutrients present, the crop will struggle, and yield will be reduced. Growers need to effectively apply micronutrients to get around these issues and one approach is to combine micronutrients with an application of a granular fertilizer blend.

Bulk blending granular micronutrients with macronutrient fertilizers is one option that has been used by many growers. Granular micronutrient sources can have varying degrees of solubility and availability. Materials that are 100 per cent sulfate are soluble and available after application, whereas materials that are 100 per cent oxides are not water soluble, not immediately available, and cannot correct nutrient deficiencies in the year that they are applied. Hybrid granules containing both oxides and sulfates in different proportions exist as well and are called oxysulfates. While bulk blending granular micronutrients can achieve high rates of micronutrient application suitable for building soil levels there are some

drawbacks. The low percentage of the blend made up of micronutrient granules, coupled with the segregation of the micronutrients due to different particle sizes relative to the NPK sources, result in uneven placement of the micronutrients in the field and uneven crop response.

Gaining in popularity are liquid micronutrient fertilizer coating products. An example is NutriAg's FertiCare line of products.

Coating granular blends with micronutrients avoids the distribution issue noted above and ensures all plants have equal access to the micronutrients. Handling the liquid coating products is straightforward; they are sprayed onto the granular blends or pumped into blenders during mixing.

There is a physical limit to the amount of liquids that can be applied onto granular blends which limits the total amount of micronutrient that can be applied, reducing their utility for building soil levels of micronutrients. These products are better suited for providing an evenly distributed and available source of micronutrients for the early part of the season. When building soil levels, the liquid products could be used on blends containing granular micronutrients.

There are a few different styles of liquid micronutrient coatings on the market today. Oil-based suspension products have high micronutrient analysis because they are suspension products formulated with insoluble micronutrients in the form of oxides, and in some cases carbonates. The particle size in the suspensions should make them more available compared to an oxide granule, but the solubility is low, particularly in soils with higher pH.

NutriAg's FertiCare micronutrient coatings contain soluble nutrients immediately available for plant uptake and use natural chelation technology to further increase availability compared to sulfates or oxides. This means less nutrient applied per acre which limits impact on the environment while resulting in greater micronutrient use efficiency, improved early season growth and increased yields.

Micronutrient applications are known to impact fertilizer use efficiency and with costs of many macronutrient inputs rising, the relatively low cost of a liquid micronutrient coating is a good insurance strategy to protect a significant investment on the farm.

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THANK YOU FOR GROWING WITH US.

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