Micronutrients Key to Better Yields

Sometimes the smallest things can unlock our greatest potential.

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Summary: *In a February 2015 CropLife article, data from WinField Nutrisolutions reports indicated 60% to 75% of all crops the company sampled in 2014 had a micronutrient deficiency of some form. The following article looks at what micronutrients are, why they are important to crop and human health, and how growers can manage micronutrients to improve their crop yields.*

Science has identified 17 essential nutrients for healthy plant growth. Water and air normally provide the three most important elements: carbon, hydrogen and oxygen. The rest are generally expected to come from the soil. We are all familiar with those six nutrients required in large amounts (macronutrients and secondary macronutrients): nitrogen, phosphorus, potassium, calcium, magnesium and sulfur. There are also eight nutrients required in smaller amounts (boron, chlorine, copper, iron, manganese, molybdenum, nickel, and zinc) dubbed micronutrients. Note that nickel (Ni) has been overlooked in the past but is essential for the activity of the urease enzyme which breaks down urea into a form that can be used by the plant. Several elements that have been identified as non-essential yet beneficial plant micronutrients: cobalt, silicon, selenium, vanadium. But too often micronutrients are treated as an afterthought and deleted to control input costs. Don't sweat the small things, right?

Wrong! Smaller doesn't mean less important. In fact in many ways micronutrients hold the key to how well the other nutrients are used and how well the plant grows, develops, and yields.

What Micronutrients Do

Micronutrients are known to play many complex roles in plant development and health. These include photosynthesis, chlorophyll synthesis, respiration, enzyme function, formation of hormones, metabolic processes, nitrogen fixation, reducing nitrates to usable N forms, cell division as well as development, and regulation

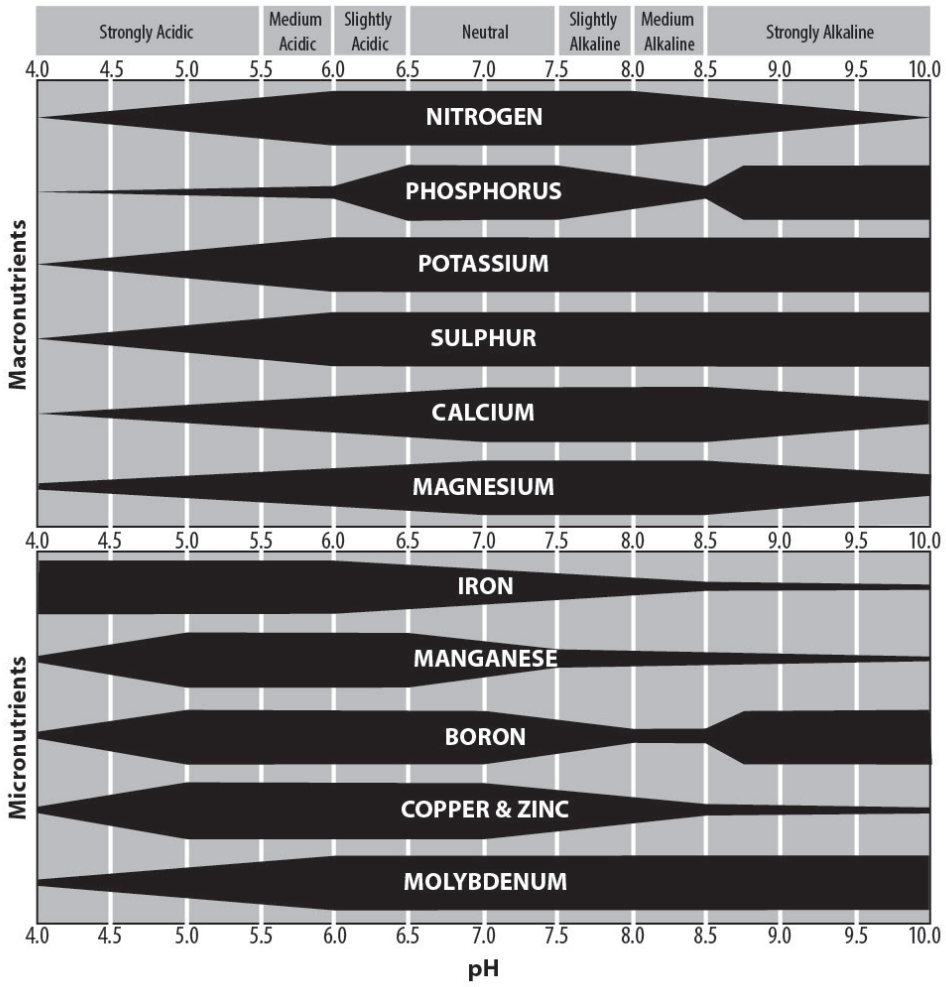

Figure 1. Available Macro- and Micronutrients in Relation to Soil pH.

Modified from Truog E. (1947). Soil reaction influence on availability of plant nutrients. *Soil Science Society Proceedings of 1946. 11-C*, 305–308.

of water uptake. Micronutrients promote the strong steady growth of crops that produce higher yields and increase harvest quality--maximizing a plant's genetic potential. In particular, their presence can have a great impact on root development, fruit setting and grain filing, seed viability, and plant vigor and health.

Micronutrient deficiency or toxicity can result in stunted growth, low yields, dieback, and even plant death. Micronutrients also benefit plants indirectly by feeding the microorganisms in the soil that perform important steps in various nutrient cycles of the soil plant root system.

Of course, the end product is the role micronutrients play when the harvest reaches the table. Increasing evidence indicates that crops grown in soils with low levels of micronutrients may not provide sufficient human dietary levels of certain elements, even though the crops show no visual signs of deficiency themselves. These unseen deficiencies can readily be found through proper laboratory analysis, which will be discussed.

The World Health Organization reports that micronutrient

"Micronutrients are important both to crops and human health..."

malnutrition contributes substantially to the global burden of disease. In 2000, the World Health Report identified iron and zinc deficiencies as being among the world's most serious health risk factors. Micronutrient malnutrition is known or suspected to contribute to a wide range of impairments, including reduced resistance to infections, metabolic disorders, learning disabilities, and stunted development and growth of infants and children.

Micronutrients and Soil

Micronutrients occur naturally in soil minerals, which gradually break down from rock minerals and are released in forms that are available to plants. Some micronutrients are reintroduced to the soil during decomposition of organic matter from plants and animals.

A critically important concept related to micronutrients is that of their availability to plants. Micronutrients can sometimes be present in soils but not in a chemical form that roots are able to absorb. Soil physical characteristics and environmental conditions play key roles in determining when and how available soil nutrients--especially micronutrients--are to plants.

- Acid leaching can remove micronutrients from the soil, as can intensive cropping in which large amounts of plant nutrients are removed in the harvest.
- High phosphorus availability in soil can diminish the availability and uptake of some micronutrients, particularly iron and zinc.
- Extremes in soil pH can result in reduced micronutrient availability (Figure 1) or even cause micronutrient toxicity. Most plants have a pH range "sweet spot" in which the micronutrients in the soil are soluble enough to satisfy plant needs without becoming so soluble as to become toxic.
- Plants grown on soils very low or very high in organic matter or with sandy or heavy clay texture can experience micronutrient deficiencies or imbalances.
- Soil erosion can carry away humus and organic matter in which some micronutrients are held.
- Cold, wet soil conditions can slow or stop plant root

development and micronutrient uptake resulting in deficiencies and indelible yield damage.

Because micronutrients are required in very small amounts for adequate nutrition, the range between "enough" micronutrient and "too much" micronutrient can be a lot more narrow than for macronutrients. Micronutrient toxicities that occur can damage or retard plant growth and affect yield. Toxicities rarely result from over-fertilization. They are more commonly associated with contaminations such as from concentrated wastewater, waste sludge being continually applied, or from excessive application of copper- or zinc-containing fungicides. Contaminated irrigation water can also be a source of micronutrient toxicity.

Micronutrient Deficiencies

It is beyond the scope of this article to list all the possible types of micronutrient deficiencies and their characteristic symptoms. Information, photos, and tables of deficiency factors are available from multiple online sources. However, some crops and soil types are more prone to certain types of micronutrient deficiency than others. Examples include boron deficiency in alfalfa; copper deficiency in wheat, corn, and soybeans; nickel deficiency in pecans; and molybdenum deficiency in soybeans. Zinc deficiencies frequently occur on calcareous, high-pH, sandy texture, high phosphorus, and eroded soils. Poorly drained soils may also be deficient. Some of the more common symptoms to look for include:

- stunted growth
- delayed maturation
- yellowing, and wilted leaves (particularly younger leaves)
- thickened, puckered, curled, or brittle leaves
- dead growing points
- aborted flowers, heads, or seeds
- poor grain filling
- fruit deformities
- increased root disease.

These symptoms often occur in irregular patches within fields and can have a drought-like appearance. Keep in mind that there can sometimes be a "hidden hunger" for micronutrients present, in which crops don't show any overt symptoms until decreased yields are observed at harvest.

Tissue and Soil Testing

While visual symptoms and suspect soil conditions can raise the possibility of micro-nutrition deficiency, the best approach to identifying a problem and implementing a viable solution lies in regular tissue and soil testing. Your local lab or extension office can guide you through the process, but be aware of the strengths and limitations of each.

Soil testing can only measure the quantity of nutrients identified as present through analytical methods, not their total levels nor their availability to plants. By combining frequent soil testing with regular plant-tissue analysis, you can more accurately diagnose deficiencies that may be present and develop the best prescription for addressing those deficiencies. Timing is also an important element. Testing during early to mid-season plant growth may provide time to correct a problem, whereas tissue samples taken during later stages of growth are good to determine corrective actions for the next crop.

If you are dealing with a suspected problem, take plant and soil samples from both the affected areas and the unaffected areas. A comparison of results can help create a much clearer picture of the problem and the actions that should be taken.

4Rs of Nutrient Stewardship

Once the need for a micronutrient supplement has been determined, the next steps are clearly identified by the industry standards set out in the 4Rs of Nutrient Stewardship. These include determining the ***"Right Source"*** for supplying the target nutrient, applying the ***"Right Rate"*** for optimal benefit, at the ***"Right Time"*** of application during day, growth stage, or growing season. Detailed discussion of those three Rs is beyond the scope of this article; however, we will further expound on the fourth R, ***"Right Place,"*** which addresses the application placement and method.

Application Methods

Micronutrient application methods affect application rates and nutrient use efficiency. Broadcast preplant applications are usually less effective than banding beside the row or in direct seed contact. Uniform distribution of small amounts of micronutrients is a problem when micronutrients are blended with large amounts of dry micronutrient carriers. Coating dry blend materials with micronized micronutrient materials can improve distribution of small amounts of micronutrients. Seed coating is another effective means of uniformly providing small amounts of micronutrients to overcome early season shortages but may need to be partnered with other applications to provide sufficient amounts. Banding micronutrients in fluid starters beside the seed row or in direct seed contact (pop-up) is an effective application method, but special care must be given to rates of some micronutrients to avoid toxicity when placed in the seed row.

Foliar sprays or fertigation can provide micronutrients to ward off potential deficiencies or partially correct deficiencies during the growing season. When deficiency symptoms appear, indelible crop damage has already occurred but such damage can be minimized by immediate applications.

Fertigation provides the utility of applying nutrients at critical periods of crop water demand by both leaf and root absorption and avoids compaction effects of ground application (iron blight). Be sure to understand fertilizer compatibility with irrigation systems and water quality.

Foliar sprays are also well suited for the application of micronutrients. High quality sources of micronutrients are able to permeate and diffuse through the leaf surface into the plant.

Advantages of foliar sprays are that a uniform field application is easily obtained, nutrient application rates may be lower than rates used for soil application, nutrients may be "piggy backed" with other agrochemical applications to reduce application costs, and the response to the applied nutrient can be almost immediate. Thus, micronutrient deficiencies identified during the growing season can be quickly corrected. An additional benefit is that foliar applications bypass any limitations on soil nutrient availability that may be present due to pH issues. However, foliar sprays may not be as effective on younger plants that have less leaf surface area, may result in leaf burn if salt concentrations of the spray are too high, and may leave very little residual effect to replenish the soil for the next planting.

Developing Micronutrient Plan

It makes sense to have a comprehensive micronutrient plan in place to ensure that you are getting the best crop yields for the money and extra effort invested. Remember that if you allow micronutrient deficiencies to become a limiting factor in crop development, further application of water, macronutrient fertilizers, and other resources plus time may give a limited return or be wasted.

Planning begins by knowing which of your fields and which of your crops are most susceptible to micronutrient deficiencies and by routinely conducting soil and tissue tests. When problems are identified and successfully treated, you must keep good records of what was done for future reference. It is also essential to continuously monitor your fields for possible future micronutrient problems. Be aware of any special physical or environmental conditions that may affect future micronutrient availability to your crop.

Summing up

Micronutrient needs vary with the type of soil, crop planted, available nutrient source, and whether or not the crop is irrigated or dry land. For more specific recommendations, review resources that apply to your locale and discuss your test analyses with your crop advisor and your fertilizer retailer. It is important to find the best micronutrient solutions--including the correct amounts and application timing--to help you reach a complete and healthy balance of all the essential nutrients needed for vigorous crop growth and optimal yield.

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