

Nutrient Deficiencies and Toxicities – as Relevant as Ever for Crops

By W.M. (Mike) Stewart and William F. Bennett

This article briefly highlights some tips and resources that can help in recognizing and understanding nutrition problems in plants.

Crop nutrition issues are as old as farming itself. The application of plant and animal based residue to improve production appears to have started in the river basins of the Euphrates and Tigris in ancient Mesopotamia (now Iraq). Other independent developments may have occurred in the Orient and elsewhere. There have been many discoveries and contributions to the understanding of plant nutrition in the intervening centuries, and perhaps the most noteworthy of the contributors was the German scientist Justus von Liebig. He made remarkable strides in advancing the understanding of chemistry, plant nutrition and soil science and has been referred to as the father of the fertilizer industry. Liebig correctly believed that plants obtain mineral nutrition from the soil.

Today we take for granted what was once a significant discovery. Modern agronomists and other agriculturalists learn early on about the fundamentals of crop nutrition and fertilization. We learn, for example, that soils have limited reserves of nutrients held in the mineral and/or organic fraction. When these reserves are exhausted, nutrient deficiency will result and crop yield and quality will suffer. Furthermore, nutrient deficiency can be temporarily induced by environmental conditions where uptake is retarded. A classic example of this



Symptoms of P deficiency are shown on these corn plants.

is P deficiency in early season corn planted in cool moist soil conditions. Whatever the cause, nutrient deficiencies have specific visual symptoms, and recognition of the various symptoms is fundamental to effective crop scouting and agronomic practice. Knowledge of the function of plant nutrients is always helpful in determining fertilizer needs. It also will help to pinpoint the nutrient causing a deficiency symptom.

Nutrient deficiency symptoms were first noted and reported in the early 1900s. They became more widely used as a tool in diagnosing nutrient need in the 1940s and 1950s. The first standard and classic work describing and visualizing these symptoms was prepared by Howard Sprague in the book *Hunger Signs in Crops*, first published in 1941.

Nutrient deficiency symptoms can be a useful tool in de-

termining nutrient need. Other time-tested methods are soil tests, plant tissue tests (in both the field and the laboratory), and fertilizer strips for comparison. The main drawback to nutrient deficiency symptoms as a diagnostic tool is that once the symptom appears, yield levels may have already been reduced. But reacting to a symptom and applying needed nutrients may minimize yield reduction. Soil and tissue tests should be used before deficiency symptoms appear.

There are 16 nutrients that are essential for proper plant growth and function. Visual symptoms of nutrient deficiencies are distinguishable by specific features involving location, markings, color, and morphological and growth effects. The more mobile a nutrient is within the plant, the more likely it is that deficiency symptoms will occur on the lower leaves first, and vice versa. For example, K is highly mobile in plant tissue and is easily transported from one part of a plant to another. Therefore, symptoms will generally show first on older leaves as K is transported to younger tissue with the onset of deficiency.

There are exceptions to almost every rule though, and in some circumstances K deficiency can appear on younger leaves before older, as is the case with midseason K deficiency in cotton in some regions where very high K demand by developing bolls strips young leaves of K and disrupts the normal deficiency symptomology.

Nutrients such as Zn that are immobile in plant tissue will most always exhibit visual symptoms in younger tissue. **Figure 1** shows a general depiction of

termining nutrient need. Other time-tested methods are soil tests, plant tissue tests (in both the field and the laboratory), and fertilizer strips for comparison. The main drawback to nutrient deficiency symptoms as a diagnostic tool is that once the symptom appears, yield levels may have already been reduced. But reacting to a symptom and applying needed nutrients may minimize yield reduction. Soil and tissue tests should be used before deficiency symptoms appear.

There are 16 nutrients that are essential for proper plant growth and function. Visual symptoms of nutrient deficiencies are distinguishable by specific features involving location, markings, color, and morphological and growth effects. The more mobile a nutrient is within the plant, the more likely it is that deficiency symptoms will occur on the lower leaves first, and vice versa. For example, K is highly mobile in plant tissue and is easily transported from one part of a plant to another. Therefore, symptoms will generally show first on older leaves as K is transported to younger tissue with the onset of deficiency.

There are exceptions to almost every rule though, and in some circumstances K deficiency can appear on younger leaves before older, as is the case with midseason K deficiency in cotton in some regions where very high K demand by developing bolls strips young leaves of K and disrupts the normal deficiency symptomology.

Nutrients such as Zn that are immobile in plant tissue will most always exhibit visual symptoms in younger tissue. **Figure 1** shows a general depiction of

Late-season K deficiency in cotton can sometimes appear on younger leaves, as in this Arkansas plot.



Potassium deficiency typically shows first on older leaves, as on these corn plants.



Late-season K deficiency in cotton can sometimes appear on younger leaves, as in this Arkansas plot.



Zinc deficient rice, with symptoms on younger tissue.

the portion of the plant where specific symptoms are likely to first occur.

Visual deficiency symptoms are usually indicative of severe conditions and less acute shortages may not be so readily identified. The effects of other stresses such as drought

and pests can complicate diagnoses. It is worth noting too that some crops are more susceptible to specific deficiencies than others, and toxicities of some nutrients can occur as well. Therefore, it behooves those involved in crop production – from the field consultant to the university professor – to have access to an accurate and dependable reference on nutrient deficiency and toxicity symptoms. One such resource is published by the American Phytopathological Society. The book, entitled *Nutrient Deficiencies & Toxicities In Crop Plants*, is one of the timeless, dependable standards on the subject, and is recommended for the library of any agriculturist. Details on availability and purchase are shown below.

The International Plant Nutrition Institute (IPNI) also has a database of nutrient deficiency images that is under continual development. Visit the website at: <http://media.ipni.net>

The topic of nutrient deficiencies, toxicities, and balance is particularly appropriate in today's environment. As population increases and the world rumbles with the food crises, the role of agricultural producers and their advisers grow ever more important. Sound crop nutrition, and the skills and information

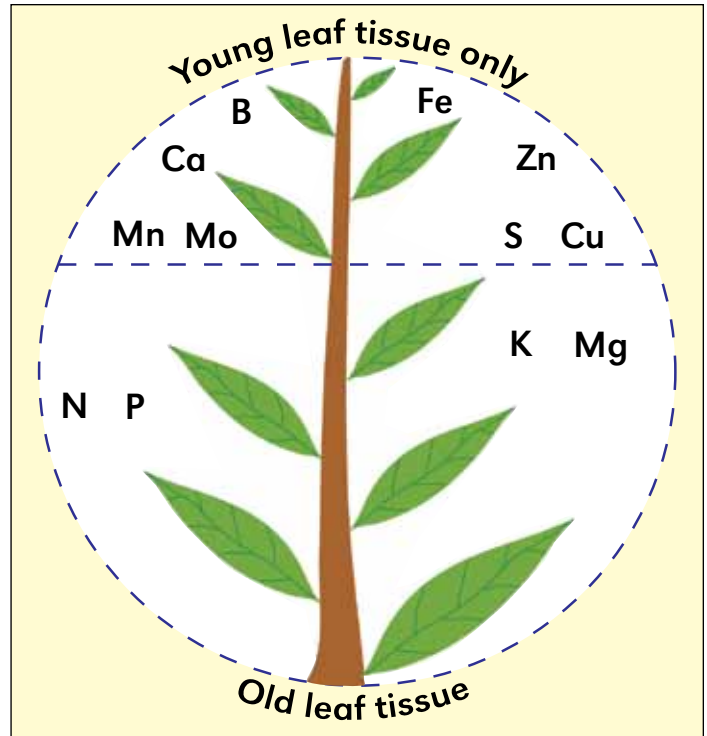



Figure 1. This generalized diagram indicates the portion of the plant where various nutrient deficiency symptoms are typically first observed. The more mobile a nutrient is within the plant, the more likely symptoms will appear on older leaves first.

necessary to implement it, is central to meeting the growing demands for agricultural goods. 

Dr. Stewart is Director, IPNI Southern and Central Great Plains Region, located at San Antonio, Texas; e-mail: mstewart@ipni.net. Dr. Bennett is a soil scientist, former Associate Dean of the College of Agriculture, and now Professor Emeritus at Texas Tech University, Lubbock.

Nutrient Deficiencies and Toxicities in Crop Plants **Book Now Available at Reduced Price**

A co-author of the accompanying article, Dr. William F. Bennett, Ph.D., is also the creator and editor of the publication titled *Nutrient Deficiencies & Toxicities In Crop Plants*. This book is one of the best-selling reference titles ever published by The American Phytopathological Society (APS).

For a limited time, readers of *Better Crops with Plant Food* are entitled to a discount of USD 30.00 (thirty dollars) off the normal price of the book, which covers more than 20 fruit and field crops with expert discussion and advice, and also includes over 300 diagnostic photos of nutrient problems.

Reduced price of USD 39.00 (thirty-nine dollars) is available until June 29, 2011. For the discounted price, visit the website: <http://www.apsnet/apsstore/shopapspress/Pages/41515.aspx>. Or call APS at 1.800.328.7560.

