ALBION®
Metalosate® Plant Nutrition News
A Compilation of Technical Information and Essential Plant Research Projects
December 2000 Volume 1, No. 4

Managing Soils to Optimize Crop Production

Soil fertility is a very important component in the management of optimal crop production. In addition to fertility, there are many other factors in the soil that directly affect crop growth. For example, soil moisture, temperature, compaction and drainage all influence the plant's ability to grow, mature and reproduce.[1]

The purpose of this newsletter is to explore some of the characteristics of the soil at a fundamental level. This information can assist us in developing optimal programs for soil applications of fertilizers and foliar applications of Metalosate® products on our crops. The better we understand the various constituents that make up our soils, the better we can manage them to improve the efficiency of the production of our crops.

Soil Texture

The mineral component of the soil is made up of particles of various sizes. The largest sized particle is sand and the smallest is clay. Silt is a particle intermediate in size to sand and clay. Loams are soils made up mixtures of these different sized particles.[2]

Most soil particles have negative charges on their surfaces. This means that they attract and hold positively charged elements or cations. The only way a cation can be removed from the surface of a soil particle is if another soluble cation replaces it. This process is referred to as cation exchange. The quantity of cations that can be held by a soil is known as the cation exchange capacity (C.E.C.).[3]

Soil pH

pH is the measure of the relative acidity or alkalinity of the soil. The solubility, and therefore the availability, of all plant nutrients is dependent on soil pH. Certain elements are more soluble under acid conditions while others are more available under alkaline conditions. See Figure 1. For this reason each crop has an optimal pH range within which it grows best.[2]

The range of pH is from 0 to 14, where 7 is neutral. A pH below 7 is acid and above this level is alkaline.[2] The availability of nutrients in the soil is optimal for most crops at neutral to slightly acid.

We can change the pH of the soil by applying amendments. Calcium carbonate ($CaCO_3$), or lime, will increase the pH of the soil. Where there is a deficiency of magnesium, we can apply dolomite, which is a form of lime that contains calcium and magnesium carbonates. Many soils in arid areas contain an excess amount of lime. These are referred to as calcareous soils and are naturally high in pH.[4]

Many fertilizer products produce acid in the soil. These include ammonium forms of nitrogen and those that contain sulfur. Liquid fertilizer blends containing sulfuric acid or other acids can also be used to reduce the pH of the soil. These are frequently applied in the irrigation water.[4]

Soil Organic Matter

Organic matter is an important component of the soil that influences its structure. It improves the infiltration rate of water and water holding capacity of the soil. As organic matter decomposes, it becomes an important source of nutrients for the crop.[5]

Salinity

A high salt content in the soil can cause serious injury to the crop. Different crop species vary in their tolerance to salinity. Generally, low quality irrigation water is the source of the salts that are introduced to the soil. However, high concentrations of fertilizers can also contribute to the salinity.[4]

The only way to reclaim saline soils is by washing the salts out of the root zone with a large amount of good quality irrigation water. Then, with adequate drainage, the salts can be leached away.[4]

The Macronutrients

Nitrogen (N) in the soil is present primarily in three forms: ammonium, nitrate and organic nitrogen. When urea is applied to the soil, it is converted into ammonium very rapidly.[3] Organic matter is an important source of nitrogen for crops. However, fresh organic matter that is very high in carbon can reduce the amount of available N in the soil.[5]

Nitrogen can also be applied in the ammonium and nitrate forms. Ammonium has a positive charge and is held on the surfaces of the soil particles due to their negative charges. Nitrification can take place in a very short time in warm, moist soils. This is the process of conversion of ammonium-N to nitrate-N by bacteria in the soil.[4]

Nitrate is the form of N that is most readily available to the crop. However, since it is not retained by the soil particles, it is also readily leached out of the root zone with the movement of water. Since nitrate is a serious contaminant of ground water, it is important to apply only the amount of nitrogen that will be needed by the crop. Careful timing of N applications to meet the crop demand will decrease nitrate pollution and increase fertilizer use efficiency.[3]

Phosphorus (P) can be found as calcium phosphates in high pH soils or as iron and aluminum phosphates in acid soils. All of these forms are sparingly soluble and the availability of P is highly dependent on pH. A soil pH of near 6.5 is where the solubility of P is the greatest.[6]

Most fertilizer forms of phosphorus are quite soluble. However, when they are introduced into the soil environment, the P is rapidly converted into the less soluble forms. Then, as plants remove phosphorus from the soil solution, a small amount of P goes back into solution to form equilibrium. Therefore, the soil has the capacity to store phosphorus and slowly release it over time.[3]

Potassium (K) is a positively charged element, or cation, which can be retained on the surfaces of the negatively charged soil particles. Some types of clays also have the capacity to hold large amounts of K within their structures. In addition, the organic matter in the soil can contain significant amounts of potassium. As a result, most soils have a tremendous capacity to store this element. However, if a soil has become depleted, these storage sites can become a very strong sink for any applied potassium. This will remove the nutrient from the soil solution and compete with the plant for the available K.[6]

Sulfur (S) must be present in the soil in the soluble sulfate form to be readily available to the crop. However, because it has a negative charge, sulfate can be repelled by the soil particles and leached out of the root zone with the downward movement of water. Therefore, it is important to carefully time the applications of sulfate forms of sulfur to meet the crop demand and to obtain the most efficient responses.[3]

The Major Cations

Calcium (Ca) in the soil is in the form of a divalent cation, which means it has two positive charges. In addition to being an important nutrient, it also exerts a strong influence on soil structure. The two charges of Ca can attach to two soil particles, causing them to stick together or flocculate. This creates openings between the clumps of particles that facilitates the movement of water and air.[2]

Magnesium (Mg) is also found in the soil as a divalent cation, so it has the same effect on the soil structure as calcium. Magnesium is a vital crop nutrient so it is important to maintain adequate levels in the soil.[3]

Sodium (Na) in the soil is in the form of a monovalent cation, which means that it has only one positive charge. It has the opposite effect on the soil structure as the divalent cations, Ca and Mg. Sodium reduces the flocculation of the soil and causes the particles to flow together. This can form a layer that is nearly impervious to the movement of water and air. Crops growing in sodium saturated, or sodic soils frequently suffer from severe water stress.[2]

The way to reclaim sodic soils is to replace the sodium on the soil particles with calcium. Then, with the downward movement of water, the sodium can be leached below the root zone. Calcium sulfate ($CaSO_4$), or gypsum, is one form of Ca that can be used for this purpose. If the soil contains free lime ($CaCO_3$), then acid-forming materials that reduce the pH can be applied to dissolve the lime and liberate Ca in the soil.[2]

Elemental sulfur can also be applied to the soil as an amendment. However, it must be converted to sulfuric acid by bacteria before it will reduce the pH. This process can be very slow, taking many months or even years to complete. As a result, the application of elemental sulfur is more gradual method of reclaiming sodic soils.[4]

The Micronutrients

Micronutrients are elements required by plants in relatively low quantities. This does not mean, however, that they are less important than the macronutrients.

Iron (Fe), manganese (Mn), zinc (Zn) and copper (Cu) are all metals, which are less soluble in the soil at a higher pH, as seen in Figure 1. This is why we frequently see deficiencies of these nutrients in alkaline soils. Molybdenum (Mo), in contrast, is much more available in alkaline soils. Boron (B) is present in the soil as borate, which is negatively charged. Since boron is not held by the soil particles, it can be leached out of the root zone with water movement.[7]

Since the micronutrients are only needed by the crop in small quantities, it is easy for a plant to get too much of one of these elements. An excessive level, or toxicity, of an element can be just as harmful to the plant as a deficiency.[8] Furthermore, too much of one element can cause adverse interactions with other nutrients by reducing or enhancing their availability.

Nutrients can be applied to crops by applications of Metalosate products. The Metalosate products are Albion's patented amino acid chelated mineral nutrients. Foliar applications of Metalosate products bypass the interactions in the soil that can render the nutrients unavailable to plants. Metalosate products can also be applied to the soil through the irrigation water. Amino acid chelated minerals are protected from many chemical reactions in the soil. Well-timed applications of the Metalosate products have resulted in very good responses in a wide variety of crops around the world.[9]

Analysis of Soil and Plant Tissue

The reason for soil testing is to determine the availability of nutrients to the plants. Analysis will also detect many of the other factors that influence nutrient availability. From the results Albion can determine the quantities of fertilizers and soil amendments required to optimize these factors and improve nutrient availability.[10]

The difficulty with soil analysis is that it cannot measure some of the most important factors that affect how a plant absorbs nutrients from the soil. Temperature, moisture conditions, compaction and drainage are just a few of these factors. This is the reason Albion also recommends plant tissue analysis. If one analyzes the leaves of the plant, one can determine exactly how much of each nutrient the plant is absorbing from the soil and accumulating in the leaf.[11] The results of plant tissue analysis can then be evaluated by Albion's exclusive T.E.A.M.® program to determine the balance between the nutrients within the plant. T.E.A.M. analysis can provide the grower with important information in addition to soil analysis, which is very useful in managing soil applications of fertilizers and amendments and foliar applications of Metalosate products.[9]

Conclusion

Crop production is highly dependent on the fertility of the soil and other factors that affect the ability of the plant to absorb nutrients from the soil. The better we understand the various characteristics of our soils, the better decisions we can make on how to manage them to produce our crops most efficiently.

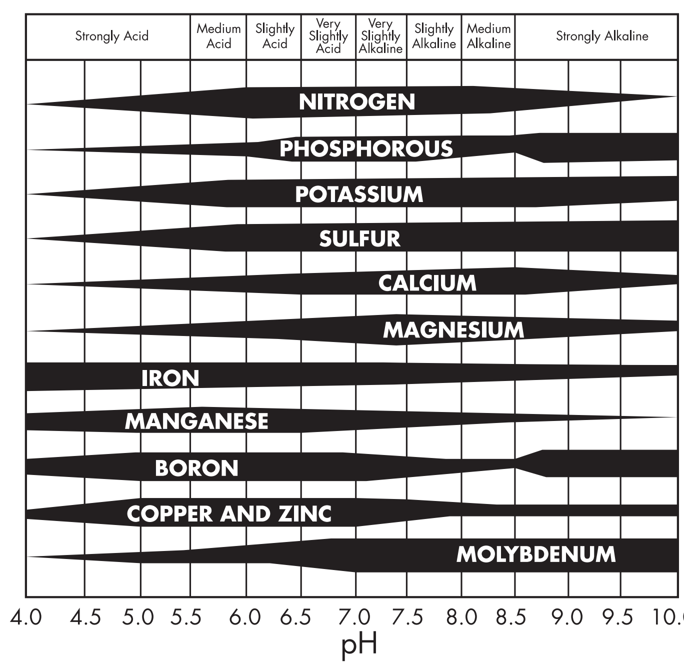

Figure 1. How soil pH affects availability of plant nutrients.

Albion highly recommends the use of the T.E.A.M. program and the Metalosate products to enhance the value of your fertility program. Please contact your nearest Albion representative or see our website for more information on these important tools that can optimize the efficiency and profitability of your crops. ꟹ

References

1. Dickinson, K., "Managing Soils to Optimize Crop Productions," Proc. 94th Annual Meeting, Washington State Horticultural Assn., 89-91, 1998.

2. Donahue R.L., Miller, R.W. and Shickluna, J.C., Soils: An introduction to soils and plant growth, (Englewood Cliffs, NJ: Prentice-Hall) Fourth Edition, 1977.

3. Mengel, K. and Kirkby, E.A., Principles of Plant Nutrition, (Bern: International Potash Institute) Second Edition, 25-31, 1979.

4. California Fertilizer Assn., Western Fertilizer Handbook, (Danville, IL: Interstate Printers & Publishers) Seventh Edition, 1985.

5. Doran, J.W. and Smith, M.S., "Organic Matter Management and Utilization of Soil and Fertilizer Nutrients," Soil Fertility and Organic Matter as Critical Components of Production Systems, (Madison, WI: Soil Science Society of America), 1987.

6. Bohn, H.L., McNeal, B.L. and O'Connor, G.A., Soil Chemistry, (New York: Wiley-Interscience), 1979.

7. Corey, R.B., "Factors Affecting the Availability of Nutrients to Plants," Soil Testing and Plant Analysis, (Madison, WI: Soil Science Society of America), 1973.

8. Bennett, W.F., Nutrient Deficiencies and Toxicities in Crop Plants, (St. Paul, MN: APS), 1996.

9. Ashmead, H.D., et al., Foliar Feeding of Plants with Amino Acid Chelates, (Park Ridge, NJ: Noyes), 1986.

10. Evans, C.E., "Soil Test Calibration," Soil Testing and Plant Analysis, (Madison, WI: Soil Science Society of America), 1973.

11. Mills, H.A. and Jones, J.B., Plant Analysis Handbook II, (Athens, GA: MicroMacro), 1996.

ALBION®

Metalosate® Plant Nutrition News

December 2000
Volume 1, No. 4

Metalosate® Plant Nutrition News is a publication of
Albion Advanced Nutrition
101 North Main Street
Clearfield, Utah 84015-2243
USA
www.albion-an.com
Phone: (801) 773-4631
(800) 453-2406
FAX: (801) 773-4633
E-mail: info@albion-an.com

Local Representatives

Kevin Dickinson
(Intermountain US, Africa, Middle East, Europe, UK)
e-mail: kdickinson@albion-an.com
mobile: (801) 540-6035

Jeremy O'Brien
(Washington and Oregon)
e-mail: jobrien@albion-an.com
mobile: (801) 725-4197

Ludwig Voet
(California, Far East)
e-mail: lvoet@albion-an.com
mobile: (801) 726-4004

Todd Edwards
(Southwestern US, Latin America)
e-mail: tedwards@albion-an.com
mobile: (801) 726-7618