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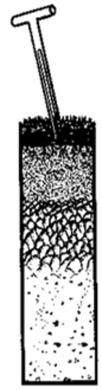
New Jersey Agricultural Experiment Station



THE SOIL PROFILE

A newsletter for information on issues relating to soils and plant nutrition in New Jersey

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Mineral Nutrition and Plant Disease – Keeping Crops Healthy with Micronutrients

A valuable resource titled *Mineral Nutrition and Plant Disease* was published by the American Phytopathological Society (APS, St. Paul, Minnesota). The second edition of the 488-page book is an expanded update. The first edition from 2007 was a bestseller for APS Press. The book (edited by Datnoff, Elmer and Rodrigues) includes chapters on every essential mineral nutrient and their role in plant physiology. It also includes information on other potentially beneficial elements silicon, sodium, aluminum, selenium, and rare earth elements. My involvement was to coauthor the chapter on manganese nutrition.

The information in this book, when properly translated into practice, can decrease the use of crop protection chemicals. The purpose of this edition of The Soil Profile newsletter is to introduce growers to this reference with a focus on micronutrients. The previous edition (available online at NJAES The Soil Profile) of this newsletter covered the major nutrients: N, P, K, S, Ca, and Mg. Macronutrients, especially N, can change soil pH and influence availability of many of the micronutrients. Thus, when crops are challenged with disease, it is important to consider the overall soil fertility and plant nutrition program.

Here are few local examples of where micronutrient nutrition provides crop protection benefits:

Manganese Fertilizer Protects Bentgrass and Wheat from Take-All Disease

Take-all diseases on wheat and on bentgrass are caused by related fungal pathogens. Manganese fertilizer can effectively suppress take-all patch on bentgrass and wheat. Repeated applications of manganese fertilizer may be necessary when microorganisms in soil convert the nutrient to the oxidized unavailable form. Applications for manganese fertilizer at 1 to 2 lbs. Mn/acre in both spring and fall are recommended for take-all disease suppression. The use of acidifying N fertilizers can help to keep applied manganese available to plants.

Take-all disease on a fairway at the Metedeconk National Golf Course in Jackson, NJ.

Chloride from Potassium Fertilizers

Corn plants are susceptible to stalk rot from various bacterial and fungal organisms. Grain fill may be limited in infected plants. Further yield loss occurs when corn stalks fall over and make machine harvest difficult. Applying hand pressure to the lower stalk is a way to determine where stalk rot is a problem.

Field research comparing different potassium fertilizers has shown that the chloride that accompanies potassium chloride (muriate of potash, 0-0-60) reduces the incidence of stalk rot and protects against crop yield loss.

Infected corn stalks can be easily crushed under thumb hand pressure.

Silicon Amendment of Soil Protects Crops

Powdery mildew is a disease that infects many crops. Field and greenhouse studies at Rutgers NJAES have demonstrated amending soils with plant available silicon provides protection against powdery mildew. Enhanced silicon nutrition has been shown to suppress powdery mildew on a wide range of crops, including pumpkin, wheat, Kentucky bluegrass, and dogwood.

Wollastonite is a naturally occurring calcium silicate mineral that supplies available silicon. This mineral also functions as a liming material. The application of wollastonite, in substitution for limestone (calcium carbonate), similarly raises soil pH and supplies calcium along with plant available silicon.

Pumpkin plant exhibiting powdery mildew disease.

Pumpkin plant protected from disease on silicon amended soil.

Rock Salt Application Benefits Asparagus

Applying rock salt (sodium chloride) helps to protect asparagus from fusarium crown rot disease. The Connecticut Agricultural Experiment Station reports on field trials showing that application of rock salt is effective against fusarium crown rot. Historically, asparagus growers would apply rock salt to suppress weeds. It works for both weed suppression and disease protection. The research findings are documented in the book *Mineral Nutrition and Plant Disease*.

On my home garden I have been applying rock salt at about 500 lbs./acre rate every year after the asparagus harvest season. The crop is very salt tolerant.

Asparagus benefits from rock salt applications.

Micronutrient Use Trends

The market for micronutrient fertilizers is expanding. The increasing demand for micronutrients may be associated with increasing crop yields and concern for depletion of micronutrients reserves from soils. Also, the publication of *Mineral Nutrition and Plant Disease* may bring renewed attention to the role of micronutrients in crop protection.

An emerging factor that may further account for the greater demand for micronutrient fertilizers is the widespread use of glyphosate in weed control, "burn down" no-till farming systems, and crop desiccation. Glyphosate is a potent chemical binding agent (metal chelator) that disables the activity of minerals.

An investigation (Saga of Soggy Sauerkraut, HortScience 2024) found that glyphosate residues interfere with availability and function of several key micronutrients: Iron, Copper, Manganese, and Zinc. High levels of residual glyphosate immobilize or inactivate the normal physiological function of many nutrients. Glyphosate may also act as an antibiotic against soil microbes which play a role in nutrient availability. Growers should be aware that fields with a legacy of glyphosate use might be more vulnerable to micronutrient deficiencies.

Even inorganic farming systems where glyphosate use is prohibited can suffer micronutrient deficiencies caused by the indirect use of this herbicide. Organic growers are allowed to use manures obtained from non-organic farms as a soil fertility input. These manures often contain glyphosate residues that suppress micronutrient nutrition of the organic crop. Organic growers should instead build soil fertility by cover cropping, legume crop rotations, and clean compost to minimize the importation of manure-based fertilizers from non-organic farming operations.

Micronutrient Diagnostics

Rutgers University Soil Test Laboratory uses the Mehlich-3 soil test extractant. The general reference values as adequate for micronutrients are as follows: Boron 0.5 to 1.5 ppm, Copper 0.5 to 20 ppm, Manganese 15 to 50 ppm, and Zinc 1 to 50 ppm. Interpretation of these soil test levels varies depending on the specific crop and soil pH.

For example, crops such as cabbage and alfalfa require higher soil fertility levels for boron. In the case of manganese, iron, and zinc soil pH has a major influence on nutrient availability, decreasing in availability as soil pH increases.

Molybdenum availability increases as soil pH increases. Some micronutrients (Molybdenum, Nickel, Chlorine, and Cobalt) are not directly evaluated by soil test but soil pH, field history, fertilizer source materials, and cropping system should be taken into consideration. The presence of glyphosate residues in soil is another factor to consider along with the soil test value.

Plant tissue analysis can be used as a diagnostic tool for micronutrients. While interpretation of nutritional status varies by crop and plant part that is sampled, general sufficiency guidelines for tissue concentrations on a dry matter basis are as follows: Boron in monocot plants 6 to 8 ppm, Boron in dicot plants 20 to 60 ppm, Copper 5 to 20 ppm, Iron 50 to 250 ppm, Manganese 25 to 300 ppm, Molybdenum 0.3 to 1.0 ppm. Nickel 0.1 to 1.0 ppm, Cobalt 0.02 to 0.5 ppm, Zinc 20 to 300 ppm, Chlorine 2000 to 10,000 ppm.

Boron is the most often needed micronutrient for many crops grown in New Jersey. Manganese is frequently found to be deficient in soybeans, wheat, and occasionally vegetable crops grown on sandy coastal plain soils. Iron deficiency occurs on blueberries and other crops that require strong acid (pH 4.5 to 5.5) soil conditions. Zinc deficiency is common in tree fruit crops and tends to be associated with periods of cool, wet, cloudy growing conditions. Molybdenum requirements are higher for legume crops; keeping soil pH in the 6.5 to 6.8 zone enhances its availability.

Cultural Practices

Certain agronomic practices can help to prevent micronutrient deficiencies. Careful choice of macronutrient fertilizers can impact supply of micronutrients. For example, common potassium fertilizers typically supply an ample amount of chlorine as chloride. Because many micronutrients are very sensitive to soil pH conditions, it is important to apply limestone carefully to meet the needs of the crop without exceeding its optimum soil pH level. The use of acid forming ammonium source N fertilizers enhances the availability of Manganese, Iron, and Zinc from soil.

Cultural practices and tillage can influence nutrient availability. For example, the use of packers to create a firm seed bed can improve the availability of manganese.

When a deficiency of manganese or iron occurs, application of the nutrients to the soil is generally not economical or effective for correction. Manganese and iron fertilizers are most effective when sprayed on the plant foliage. In many cases, repeated foliar applications of the micronutrient fertilizer are necessary. A soil test should be performed to see if excessive pH may be a contributing factor to the deficiency. Acidification of high pH soils can help to correct manganese and iron deficiencies.

Where organic growers need to apply micronutrient fertilizer, they can generally use many of the same sources as other farms. However, the organic grower must first use soil testing, plant tissue analysis, or other diagnostics to document that specific micronutrients are deficient. Also, they are advised to check with their organic certifier to ensure that the micronutrient fertilizer source is approved.

All growers may benefit by consulting the previously mentioned book: *Mineral Nutrition and Plant Disease.* This volume provides a wealth of information on how to manage soil fertility and plant nutrition for crop health. Mineral nutrition when properly managed has the potential to sustainably reduce the use of pesticides. For more information on how to manage the major plant nutrients for crop health, visit The Soil Profile newsletter: https://njaes.rutgers.edu/soil-profile/pdfs/sp-v29.pdf

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