When are Secondary or Micronutrients Needed for Tennessee Farm Fields?

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This fact sheet provides a listing of secondary and micronutrient soil tests that are available through the University of Tennessee Soil, Plant and Pest Center in Nashville (http://soilplantandpest.utk.edu/planttissue.html). It also summarizes all of the university's secondary and micronutrient recommendations and guidelines based on current research. Some recommendations are based upon soil test values (Table 1) interpreted as either satisfactory (levels adequate for excellent crop production) or unsatisfactory (levels indicating a need for fertilization). For other micronutrients, such as boron or molybdenum, a general recommendation is made for those crops observed to respond consistently to such fertilization. For copper, the soil test is currently only used to monitor changes in soil copper levels, especially where manures, biosolids or byproduct materials are being utilized.

A general discussion is provided for sulfur, as it is often included in fertilizer blends, but seldom increases yield in Tennessee. Soil testing along with a plant analysis will give a better diagnosis of the need for sulfur application. A weak acid extractant called Mehlich 1 is used by UT to test soils for nutrient levels. Critical secondary and micronutrient soil test values (the soil test value below which a recommendation for use of the nutrient is warranted) listed in this publication are only valid when the laboratory testing your soil uses the Mehlich 1 soil test for phosphorus (P), potassium (K), calcium (Ca), magnesium (Mg), zinc (Zn), manganese (Mn), iron (Fe), copper (Cu), and boron (B) or the ammonium acetate extractable soil test for sulfate-sulfur (SO_4-S).

Table 1. Guidelines for Selecting Secondary and Micronutrient Soil Tests			
Test	**Crop**	**Location**	**General Conditions**
Calcium (Ca)	Tomatoes and Peppers	Tomato and pepper producing areas.	Sandy or light textured soils. Where blossom-end-rot is an annual problem.
Magnesium (Mg)	Tomatoes, Tobacco, Cabbage, Grapes	Cumberland Plateau, Highland Rim	Sandy or light-textured soils. Magnesium deficiencies in each of these crops may be induced by excessive amounts of potassium or ammonium fertilizers.
Sulfate-Sulfur (SO_4-S)	All	Problem-solving in trouble fields. Provide basic information when observing plant S deficiency symptoms such as general chorosis or lack of response to nitrogen.	
Zinc (Zn)	Corn, Snap beans	Cumberland Plateau, Middle Tennessee	When soil pH is above 6.0 or lime is applied and phosphate is high.
Iron (Fe)	Ornamentals (only)	Isolated or problem areas.	High soil pH.
Manganese (Mn)	Soybeans	Isolated or problems areas.	Sandy or light-textured soils with a pH above 7.0.
Boron (B)	Tobacco	All	All

Secondary Nutrients

Calcium (Ca)

The Ca soil test is used for tomatoes and peppers. If calcium tests below 500 pounds per acre and soil pH is 6.1 or above, then 500 pounds of gypsum (calcium sulfate) per acre are recommended to reduce the risk of blossom-end-rot in tomatoes and peppers. However, if limestone is recommended and applied, there is no need to apply gypsum. A calcitic (at least 50 percent calcium carbonate content with less than 10 percent magnesium carbonate content) lime source may be beneficial where there is a history of blossom-end-rot.

Magnesium (Mg)

Most soils in West Tennessee contain adequate supplies of magnesium and do not normally need additional magnesium except in perhaps isolated cases (sandy soils, soils with excessive K). The same is true for soils in East Tennessee. However, some soils on the Cumberland Plateau and the Highland Rim have been found to contain low levels of magnesium. Therefore, the greatest potential for use of the magnesium soil test is in these areas.

Soils testing less than 40 pounds magnesium per acre may need supplemental magnesium fertilization. Crops for which magnesium is recommended when the soil tests below 40 pounds per acre include grapes, tomatoes, tobacco, cabbage and ornamentals. Twenty pounds of magnesium per acre is the recommended application rate. When soil pH is low, dolomitic (magnesium content of at least 10 percent) limestone is the recommended magnesium source, since it can be used to correct both low magnesium and soil acidity. In addition, dolomitic limestone is the most economical source of magnesium and provides a favorable balance between calcium and magnesium. If calcitic limestone is used, or lime is not needed, magnesium sulfate (Epsom salt) or potassium-magnesium sulfate (K-mag) should be used to supply the 20 pounds of magnesium per acre.

Sulfur (S) as sulfate-sulfur (SO_4-S)

Plant available sulfur in the soil is found as the sulfate form (SO_4-S). The UT Soil, Plant and Pest Center uses an ammonium acetate extract to determine sulfate-sulfur in the soil sample submitted for analysis. Sulfate-sulfur (SO_4-S) soil tests are sometimes prone to failure because of environmental conditions or the presence of subsoil sulfate-sulfur that is not accounted for in the soil test. Growers suspecting a sulfur problem can verify the deficiency using plant analysis. Field plot research and demonstrations with corn and wheat in Tennessee have not shown a consistent response to added sulfur.

Excess sulfur content of forage crops is known to cause animal nutrition problems such as animal copper deficiency. Sulfur should not be applied to these crops without plant analysis results supporting a deficiency. Plant analysis, with interpretation of results, is currently available from the UT Soil, Plant and Pest Center (http://soilplantandpest.utk.edu/planttissue.html), and also is offered by many privately operated laboratories.

The organic matter in soil is the main sulfur reservoir. Topsoil may typically contain several hundred pounds of sulfur per acre primarily in organic form. As organic sulfur forms are broken down by soil microbes (mineralized) each year, approximately 4-13 pounds of sulfur may be released through the action of soil microbial activity. Sulfur is also deposited with rainfall, but this amount has significantly dropped in the last few years. About 5-9 pounds of sulfur per acre may be deposited by rainfall annually in Tennessee. Industries responded to a call for cleaner air and have fewer emissions. The potential for crop response to added sulfur is greatest for very low organic matter (under 1 percent) sandy to silty soils, under conditions not favorable for mineralization of organic sulfur fractions (cold or waterlogged soils) or in areas very isolated from industrial emissions.

Growers choosing to add sulfur as an "insurance policy" should not exceed a rate of application in the range of 15-25 pounds of actual sulfur per acre. Elemental sulfur and ammonium sulfate are common fertilizer products used to supply sulfur in a blend with primary nutrients. The sulfur from ammonium sulfate is very quickly available to the plant and is more appropriate for use with cool-season crops (i.e. a spring fertilizer application to wheat). Sulfur supplied from elemental sulfur must first be converted by soil microbial activity to the sulfate form. This process may take several weeks or longer when incorporated into the soil, and surface applications may slow conversion considerably more than several weeks. Also, one can expect some acidity produced and a lowering of soil pH after conversion.

Micronutrients

Boron (B)

A Mehlich 1 soil test for boron is currently available through the University of Tennessee Soil, Plant and Pest Center in Nashville. A general boron recommendation is made for cotton, alfalfa, broccoli, cauliflower and cabbage. Two pounds of boron per acre are recommended for alfalfa, broccoli, cauliflower and cabbage.

One-half pound of boron per acre is recommended for cotton when the pH is above 6.0 or anywhere lime is used.

A pound of boron per acre is recommended for burley or dark tobacco when soil tests less than 1.2 pounds of boron per acre, anywhere deficiency symptoms have been noted previously or where plant analysis results show a need for boron. This is a one-time application for tobacco, to be followed with additional soil testing next spring.

Iron (Fe)

The iron soil test is used only for ornamental plants such as azaleas, hydrangeas, etc. The department of Plant Sciences makes all ornamental recommendations for iron, as well as for all other micronutrient and secondary nutrients.

There is no established need in Tennessee for fertilization with iron for any agronomic, vegetable, tree fruit or small fruit crop. Thus, the iron test should not be requested for these crops. If, however, iron is requested on samples for crops other than ornamentals, it will be determined and always reported as sufficient. Iron sulfate is a commonly used and locally available source for iron. Chelated iron sources are often more appropriate for established plantings (for example chorotic blueberries) when soil pH is very much above the desired range. Such use is not based upon soil test results but upon plant appearance [unthrifty and usually chlorotic (yellowing) condition].

If soil is tested prior to plant establishment, then a more desirable approach is to avoid an iron deficiency by lowering the soil pH using elemental sulfur or other acidifying amendments well ahead of planting. The soil test lab report gives specific instructions for amount of elemental sulfur (the most economical soil acidifying material) to use. Lowering of soil pH or attempted correction of iron deficiency after establishment of shrubs or small fruits is a salvage attempt that often does not achieve the desired result.

Manganese (Mn)

Manganese is recommended only for soybeans when soil pH is above 7.0 and soil test Mn is below 16 pounds per acre. The recommendation is to apply 20 pounds of manganese per acre broadcast just prior to planting.

Note: Manganese should not be confused with Mg nor should it be requested when Mn toxicity (low soil pH) is the problem.

Molybdenum (Mo)

A general molybdenum recommendation, as a seed treatment, is made for soybeans. Treat seed with 0.2 ounce actual molybdenum per bushel when the soil pH is 6.5 or below. This treatment can be accomplished by applying either 0.5 ounce of sodium molybdate per bushel of seed or following the product label for specific liquid hopper-box applied sources containing fungicides. Research has shown very favorable results to seed application of molybdenum down to a soil pH of about 5.8. Liming excessively acid soils can alleviate the need for soybean seed treatment.

Zinc (Zn)

A general zinc recommendation is made for corn and snap beans on soils from those counties where zinc deficiencies commonly occur (Middle Tennessee and Cumberland Plateau). However, when zinc is tested on a soil sample from any county for corn or snap beans, the zinc recommendation is based on the result of the soil test as follows: If the zinc results are 2 pounds per acre or less, 5 pounds of elemental zinc per acre will be recommended for corn or 2 pounds per acre for snap beans.

Also, a general statewide zinc recommendation of 2 pounds of zinc sulfate per 1,000 square feet is made for pecan trees. Unless deficiency symptoms persist, this should be considered as a one-time application.

When a zinc soil test is requested for crops other than corn or snap beans, the results are always reported as sufficient. Zinc sulfate is the commonly used and locally available source for zinc.

Other

No research information is currently available to suggest the use of other micronutrients [i.e., chlorine (Cl), copper (Cu)] other than those described in this fact sheet. The Mehlich 1 soil test for copper has been used solely for monitoring changes in soils continually receiving biosolids high in copper content in order to avoid potential copper toxicity problems with grazing animals. No fertilizer recommendation should be made on the basis of this soil test.

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