AG-FS-3331
1987

MANAGEMENT OF SOILS
IN **SOUTH-CENTRAL** MINNESOTA
A Correspondence Course

Unit 3: Understanding Secondary Nutrients in Soils

George Rehm

Objectives

- Understand the need for secondary nutrients for crop production in south-central Minnesota.
- Understand the importance and use of soil tests for predicting secondary nutrient needs in south-central Minnesota.

Minnesota Extension Service • University of Minnesota

SECONDARY NUTRIENTS AND THEIR IMPORTANCE

Calcium (Ca), magnesium (Mg), and sulfur (S) historically have been classified as secondary nutrients. They are just as important as all other nutrients needed for plant growth; however, plant requirements for these nutrients are lower than those for nitrogen (N) and potassium (K) (Table 1). This lower requirement has resulted in the use of the word "secondary."

Table 1. Nutrients removed by several crops.

Crop	Per-Acre Yield	Nutrient					
		N	phosphate	potash	Ca	Mg	S
		lb/A					
corn	150 bu	235	90	185	28	28	24
corn	grain only	135	53	40	2	8	10
soybeans[b]	40 bu	150[a]	35	55	7	7	4
wheat	60 bu	105	44	74	11	14	8
alfalfa	6 ton	270[a]	60	270	168	31	29

[a]Nitrogen used by these crops is supplied from both soil and air.
[b]Grain only.

Calcium helps maintain the structure of cell walls. Without adequate Ca, plants would not remain rigid and would lodge easily.

Magnesium, an important component of chlorophyll, is actively involved in the food manufacturing process that occurs in all plants. In most crops, if Mg is deficient the lower leaves start to turn yellow while new leaves remain green. With corn, there is a striping for the entire length of the leaf. Mg deficiency is rare in south-central Minnesota.

Sulfur, like N, is an important component of some amino acids, the building blocks of the proteins needed in plant growth. In contrast to nitrogen, relatively small amounts of S are needed for crop production.

THE SECONDARY NUTRIENTS IN THE SOIL

Calcium

Calcium is found in the film of water that surrounds soil particles and is associated with the negative charges on the surface of clay particles and soil organic matter. The amount of Ca in soils increases as the pH increases. Since relatively little Ca is used by growing crops, most agricultural soils are well-supplied with this nutrient even if they are very acid.

Large quantities of Ca are naturally present in soils in south-central Minnesota, so no Ca will be needed in a fertilizer program.

Magnesium

Magnesium, like Ca, is found in the water film and is associated with clay particles and soil organic matter. Magnesium is used in relatively small amounts for crop production. In general, soils in south-central Minnesota have naturally high levels of Mg. These high Mg levels are the result of the soil-forming processes that have taken place for many years in this region. If agricultural limestone is needed and used, adequate amounts of Mg are supplied

in the dolomitic limestone. Therefore, there should be no need to add Mg to a fertilizer program in south-central Minnesota.

Ca/Mg and Mg/K Ratios

Some agricultural advisers believe there are "ideal" ratios of Ca/Mg, Mg/K, and Ca/K in soils and that these ratios provide an indication of the balance of nutrients in soils. For example, there are some who attempt to convince farmers that the amount of Mg applied in dolomitic limestone can be harmful for crop production. Research, however, has shown that use of relatively high rates of Mg as in a dolomitic limestone program has no harmful effect on crop yield.

The Ca/Mg, Mg/K, and Ca/K ratios are simply statements of the relative proportions of Ca, Mg, and K. Ratios do not give any information about the actual level of these nutrients in soils. For example, the Ca/Mg ratio may be ideal for some very sandy soils, yet the actual amount of Mg may be too low for crop growth. In this case the Ca/Mg ratio concept would give the wrong information.

The idea that soils had an ideal Ca/Mg ratio originated from studies conducted in New Jersey in the 1940s that suggested an ideal ratio of 6.5 to 1.0. The ideal Mg/K ratio was thought to be 2.0 to 1.0. Recent research in several states, however, has shown that these ratios can be altered over a wide range without harming yield. This research has clearly shown that fertilizer recommendations should be based on the absolute amount of these nutrients in the soil rather than on the ratio of one nutrient to another. Thus, growers should *ignore* any suggestions that their soil has a less-than-ideal Ca/Mg, Mg/K, or Ca/K ratio or that nutrients are out of balance.

Sulfur

Sulfur, like N, exists in the soil in several forms and is easily transformed from one form to another. Approximately 90 to 95 percent of soil S is in the organic matter.

Plants absorb S in the sulfate (SO_4) form. There are several sources of sulfate sulfur (SO_4-S) for crop production. The soil organic matter is the primary source. Before the S in the organic matter can be used by crops, it must be converted to SO_4-S by a process called mineralization. The amount of SO_4-S that becomes available through mineralization varies with soil texture, the percentage of organic matter, soil temperature, and soil aeration. In general, more SO_4-S becomes available from mineralization in fine-textured soils than in sandy soils. Research trials in south-central Minnesota have demonstrated that non-sandy soils in the region produce enough SO_4-S each year by mineralization to meet the crop requirements for S. Consequently, no S is needed in a fertilizer program.

Rainfall also contributes small amounts of S to the soil system. Relatively small amounts of S, however, are supplied by this source unless there is a lot of industry in the immediate area. Consequently, only small amounts of S will be supplied by rainfall in south-central Minnesota.

Small amounts of S also can be supplied to the soil by some herbicides and rootworm insecticides. The amount of S supplied by these sources, however, is usually very small.

In the past, certain fertilizers such as concentrated superphosphate (0-20-0) that were used to supply other needed nutrients contained substantial amounts of S. As these fertilizers have been replaced by higher analysis materials, the amount of S supplied by this means has dropped substantially.

Because the S content of modern fertilizers is very low, the amount of S coming from rainfall is substantially less than in the past, and crop yields continue to rise, there are some who believe that the need for S in a fertilizer program will extend to more geographical areas in future years. Current recommendations in Minnesota are to include S in a fertilizer program where crops are grown on sandy soils that have a low organic matter content. Very few areas of these sandy soils are found in south-central Minnesota.

Studies are now underway to evaluate the effect of S in a fertilizer program on the yield and quality of corn and alfalfa grown in southeastern Minnesota. To date, alfalfa, which uses the most S, has not responded to the fertilizer S and the quality of the alfalfa hay has not been affected.

Fertilizer S did increase the yield of corn at one location. A broadcast rate for S of 10 lb/A was satisfactory for maximum production. Three conditions probably contributed to the response to S at the site. The soil had a low organic matter content (less than 2 percent), the yield was high (about 190 bushels per acre), and rainfall was above normal. The results from this one site do not mean that S is needed for corn production on all of the soils in southeastern Minnesota. On the contrary, fertilizer S is probably needed on very few.

CALCIUM, MAGNESIUM, AND SULFUR IN A FERTILIZER PROGRAM

From the preceding paragraphs, it should be evident that there is no widespread need for Ca, Mg, and S in a fertilizer program in south-central Minnesota.

The soils contain adequate amounts of Ca for growth of all crops. There certainly should be no need to supply Mg. If there is any doubt, a soil test for Mg is available from the University of Minnesota Soil Testing laboratory.

A soil test for S also is available. This test, however, is appropriate only for sandy soils. The test will *not* accurately predict S needs in south-central Minnesota, so there is no reason to have soil samples from this region analyzed for S.

RELATED READING

AG-FO-0725, *Magnesium for Minnesota Soils*
AG-FO-0794, *Sulfur for Minnesota Soils*

Issued in furtherance of cooperative extension work in agriculture and home economics, acts of May 8 and June 30, 1914, in cooperation with the U.S. Department of Agriculture. Patrick J. Borich, Dean and Director of Minnesota Extension Service, University of Minnesota, St. Paul, Minnesota 55108. The University of Minnesota, including the Minnesota Extension Service, is committed to the policy that all persons shall have equal access to its programs, facilities, and employment without regard to race, religion, color, sex, national origin, handicap, age, veteran status, or sexual orientation.