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G74-165 Understand Your Soil Test: *Calcium, Magnesium, Boron, Copper, Chlorine, Molybdenum*

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Understand Your Soil Test: *Calcium, Magnesium, Boron, Copper, Chlorine, Molybdenum*

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It is possible to analyze soil samples for any of the 13 essential elements which plants obtain from the soil. This does not mean that the results obtained can be used to predict adequacy or deficiency for plant growth. The value obtained from any chemical procedure used to determine each element must be shown to be related to (1) crop response from application of that element (correlation) and (2) the soil test level at which response occurs (calibration). Crop response is usually measured as yield, but may also be a quality factor. Field plot and greenhouse research are used to study these relationships on a range of Nebraska soils, so that soil tests can be used effectively to determine crop needs for fertilizer.

Research with different soils ranging from deficiency to adequacy in a plant nutrient is necessary to obtain a soil test correlation and calibration. Soils deficient in calcium, magnesium, boron, copper, chlorine, and molybdenum have been rarely if ever found in Nebraska. Consequently, confidence in the interpretation of soil tests for these elements is less than for phosphorus and zinc tests, which have a good research base. The need for testing for nutrient elements which have not been shown to be deficient in Nebraska is open to question.

However, with intensive cropping, certain soils may become deficient. Hopefully, soil tests can be used to detect problems before they become serious. It should be remembered, however, that interpretation of such soil tests requires good professional judgement, since the research base may be from soils which are much different from those found in Nebraska.

The UNL Soil Testing Laboratory does not routinely provide soil tests for calcium (Ca), magnesium (Mg), boron (B), molybdenum (Mo), or chlorine (Cl) since deficiencies have rarely, if ever, been demonstrated in Nebraska soils. Experimental soil tests for some of these elements are determined by the UNL Soil Testing Laboratory for Agricultural Experiment Station projects. The following is presented to provide the best available guidelines for interpreting results of soil tests for these elements.

Calcium and Magnesium Interpretation

Ca and Mg are classified as secondary nutrients. They are secondary only in the probability of deficiencies and are taken up by plants in quantities similar to phosphorus. These two elements along with potassium (K) and hydrogen (H, which causes soils to become acid) are adsorbed to the surface of clay and organic matter in the soil by electrostatic charge. These are called "exchangeable cations", because as ions with positive charges they are held on the clay surface and exchange with cations in the soil solution. The capacity of the soil to hold these cations against leaching with water is called cation exchange capacity. Nebraska soils hold relatively large quantities of exchangeable Ca, Mg and K in reserve.

Soil tests measure the amounts of exchangeable Ca and Mg since this is the plant-available form. Natural processes result in Ca, Mg and K on clay and organic matter being replaced by H. When agricultural liming materials are applied, chemical reactions occur so that the Ca in the lime replaces the H to overcome the soil acidity. Dolomitic limestone supplies Mg as well as calcium and is used for liming when soil Mg levels are low. Magnesium sulfate and potassium magnesium sulfate are also used as Mg source but will not correct soil acidity.

Irrigation water in Nebraska usually contains calcium and magnesium bicarbonate, which neutralizes soil acidity and, along with other Mg salts, frequently supplies enough Mg to meet crop needs.

The use of high rates of K may result in low uptake of Mg if exchangeable Mg is already low. Mg deficiencies can be induced on some sandy soils by excessive Potassium fertilization. Ca and Mg levels have little if any effect on potassium uptake.

Most research has shown that a soil test reading of 40 to 50 ppm (80 to 100 lbs/acre) of Mg is adequate. Some laboratories report percent Mg saturation, which is the relative amount of exchange capacity that is satisfied by Mg. This is a valid approach *unless the soil contains free lime* (pH above 7.3). This indicates that a soil contains Ca in addition to that found in the exchange complex. The Missouri Agricultural Experiment Station has established ranges of percent Ca, Mg and K saturation for "balanced soil saturation. These ranges are given in the following table.

	Acceptable Percent Saturation[a]	*Minimum Soil Test Levels*
Calcium	50-75%	------
Magnesium	10-35%	50 ppm
(Potassium)	(2-5%)	(80 ppm)

[a]Applies only to neutral and acid soil. Use of percent saturation often results in gross errors if applied to soils containing free lime.

For Nebraska soils as low as 40 percent Ca saturation is probably acceptable. Some Nebraska soils are 35 percent Mg saturated and 20 percent potassium saturated, yet crop yields are not limited.

Interpreting Soil Tests for Manganese and Copper

The DTPA soil test developed at Colorado State University may be adaptable to Nebraska soils. Soils that respond to these micronutrients are so rare in both Nebraska and Colorado that correlations are lacking. Greenhouse experiments with imported Mn and Cu deficient soils have resulted in the following calibration.

DTPA Soil Test in ppm		
	Deficient	*Adequate*
Manganese	less than 1.0	1.0 ppm or more
Copper	less than 0.2	0.2 ppm or more

Some states in the eastern part of the corn belt use one soil test to detect Mn deficiencies on certain soil types and a different test to find toxic levels.

Interpreting Soil Tests for Boron

The soil test used commonly for boron is known as "hot water extractable". This procedure is used by several states, including Ohio and Wisconsin. Soils containing less than 1/4 ppm (0.5 lbs/acre) are considered deficient. Sandy soils are most apt to need boron. Alfalfa and sugar beets will show deficiency before other crops.

Boron should be used with caution, since the difference between toxic level for one crop and adequate level for another may be very narrow. In fact they may overlap. The optimum level for sugar beets may depress yields of oats or field peas.

Special precautions should be taken with irrigationd crops, since most Nebraska ground and surface water contains enough boron to supply crop needs.

Where boron deficiency is found, apply fertilizer to supply about 1 pound of boron per acre. Avoid contact with the seed.

Molybdenum and Chlorine

A 150-bushel corn crop will contain less than an ounce of molybdenum per acre. Chlorine requirements (as chloride) are even lower than for molybdenum. But chlorine will usually be present in greater quantities than molybdenum. These are indeed "trace" elements. To date, Nebraska soils appear to supply these elements in sufficient quantities to crops. No research information is available for relating need for these elements to soil tests with Nebraska soils.

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