A2523

Understanding Plant Nutrients

Soil and Applied Calcium

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Calcium (Ca) is relatively abundant in soils and rarely limits crop production. It makes up about 3.6% of the earth's crust. It is present in soil minerals such as amphibole, apatite, calcite, dolomite, feldspar, gypsum, and pyroxene. Calcium is a component of cell walls and is also important for cell division and elongation, permeability of cell membranes, and nitrogen metabolism. It is different from most plant nutrients in that it is only moved within the plant by the water moving from the roots through the leaves.

CALCIUM REACTIONS IN SOILS

Calcium is the predominant positively charged ion (Ca^{++}) held on soil clay and organic matter particles because it is held more tightly than magnesium (Mg^{++}), potassium (K^+), and other exchangeable cations. Parent material from which soils are formed also usually contain more calcium than magnesium or potassium. Therefore, soils normally have large amounts of exchangeable calcium (300–5000 ppm). Leaching of calcium through soils does not normally occur to any appreciable extent because of its relatively strong attraction to the surface of clay particles.

Calcium/Magnesium Ratios

Claims regarding the "balance" of calcium and magnesium and the need to adjust the ratio of calcium to magnesium in Wisconsin soils are unsubstantiated. Those who favor this idea suggest that Wisconsin soils contain low or deficient levels of calcium and/or toxic levels of magnesium and that calcitic limestone ($CaCO_3$) or gypsum ($CaSO_4$) is needed to correct this condition. Research conducted in Wisconsin does not support these claims. Soils with a pH above 6.0 usually contain adequate amounts of exchangeable calcium for agronomic crops. Similarly, magnesium levels in Wisconsin are not toxic, and calcium/magnesium ratios typically range from 1:1 to 8:1, which research has proven to support normal plant growth. Dolomitic lime ($CaCO_3$ + $MgCO_3$) has a calcium/magnesium ratio (about 2:1) that is within the range for normal crop growth, and it is considerably less expensive than calcitic limestone and gypsum. Research does not support using more expensive products to add calcium or change the calcium/magnesium ratio. Consult Extension publication G2986, *Soil Calcium to Magnesium Ratios—Should You Be Concerned?*, for more information.

SOURCES OF APPLIED CALCIUM

Limestone applied to correct soil acidity is the predominant source of applied calcium. The limestone quarried in Wisconsin contains 300–400 lb/ton of calcium. The amount of calcium normally added in limestone applications, combined with the relatively large amounts of exchangeable calcium in Wisconsin soils, far exceeds the 25–100 lb/a annually removed by crops. Dolomitic lime is recommended for correcting soil acidity in Wisconsin, although some calcium is supplied from other sources. Table 1 lists the amount of calcium in several liming and fertilizing materials.

Gypsum ($CaSO_4$) contains 20–22% calcium. It is not recommended as a source of calcium except for soils with a low cation-exchange capacity supporting crops that require an acidic soil. Recent Wisconsin research has shown that potatoes may benefit from added calcium when grown on sandy soils with low calcium levels. High rates of potash applied to potatoes depress calcium uptake. The additional calcium improves resistance to bacterial soft rot and internal brown spot and consistently improves potato grade.

Table 1. Sources of calcium.

MATERIAL	APPROXIMATE CHEMICAL FORMULATION	PERCENT CALCIUM
Calcitic lime	$CaCO_3$	40
Dolomitic lime	$CaCO_3 + MgCO_3$	22
Gypsum	$CaSO_4 \cdot 2H_2O$	22
Ordinary superphosphate, 0-20-0	$Ca(H_2PO_4)_2 + CaSO_4$	20
Papermill lime sludge	————	38
Slaked lime	$Ca(OH)_2$	54
Triple superphosphate, 0-46-0	$Ca(H_2PO_4)_2$	14

DIAGNOSTIC TECHNIQUES

Calcium deficiency is rare for Wisconsin field crops. The few known instances were usually associated with acid soils (pH 5.0 or less) low in organic matter. Potatoes and apples on higher-pH, sandy soils may respond well to added calcium.

Deficiency Symptoms

When calcium is deficient, the terminal buds and roots fail to develop. Deficiency symptoms show up first at the growing points, because calcium is immobile in plants. In calcium-deficient corn, the new leaf tips stick together and prevent the normal emergence and unfolding of new leaves, a condition known as buggy whipping. Other stresses, such as herbicide injury, also may cause buggy whipping; therefore, use caution in making such diagnoses.

Soil Analysis

Available calcium is estimated by measuring exchangeable calcium. Optimum soil-test levels for exchangeable calcium are 400–600 ppm for sandy soils and 600–1000 ppm for silty, clayey, and organic soils. This test usually is not required if dolomitic lime is used to correct soil acidity because the lime supplies both calcium and magnesium in a favorable ratio. Soils low in calcium often have low pH and require lime, although repeated high potassium additions on sands may result in neutral soils relatively low in calcium.

Plant Analysis

Table 2 presents critical concentrations of calcium for common Wisconsin field crops. The calcium concentration of plant tissue, unlike that of nitrogen, phosphorus, and potassium, increases as plants mature. It is important, therefore, to indicate the stage of maturity when sending in plants for analysis. Leaf-tissue analysis is not useful for determining whether adequate calcium is reaching plant storage organs, such as potato tubers or apples, because calcium might be moving readily to the leaves but not to other plant parts. See Extension publication A2289, *Plant Analysis: A Diagnostic Tool*, for additional information.

ADDITIONAL INFORMATION

These publications in the *Understanding Plant Nutrients* series are available from your county Extension office:

Soil and Applied Boron	(A2522)
Soil and Applied Calcium	(A2523)
Soil and Applied Chlorine	(A3556)
Soil and Applied Copper	(A2527)
Soil and Applied Iron	(A3554)
Soil and Applied Magnesium	(A2524)
Soil and Applied Manganese	(A2526)
Soil and Applied Molybdenum	(A3555)
Soil and Applied Nitrogen	(A2519)
Soil and Applied Phosphorus	(A2520)
Soil and Applied Potassium	(A2521)
Soil and Applied Sulfur	(A2525)
Soil and Applied Zinc	(A2528)

Table 2. Calcium plant-analysis interpretations for common Wisconsin field crops.

			INTERPRETATION			
CROP	**PLANT PART SAMPLED**	**TIME OF SAMPLING**	**DEFICIENT**	**LOW**	**SUFFICIENT**	**HIGH**
			%			
Alfalfa	Top 6 inches	Bud	<0.50	0.50–1.10	1.11–2.00	>2.00
Corn	Earleaf	Silking	<0.10	0.10–0.30	0.31–0.60	>0.60
Oat	Top leaves	Boot stage	<0.10	0.10–0.20	0.21–0.50	>0.50
Soybean	First trifoliate	Early flower	<0.50	0.50–1.10	1.11–2.00	>2.00

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