A3556

Understanding Plant Nutrients

Soil and Applied Chlorine

E.E. Schulte

Chlorine (Cl) was not proven to be essential to higher plants until 1954, when researchers in California purified the growing medium and environment sufficiently to show response to added chlorine by several crops. The earth's crust contains about 500 parts per million of chlorine, with average soil concentration estimated at 100 ppm. Chlorine is a "universal contaminant." It is present as chloride in ocean water and gets into the atmosphere as ocean spray. Soils close to coastlines can receive more than 100 lb/a annually of this element in rainwater. Amounts decrease with distance from the coast.

The names **chlorine** and **chloride** are frequently confused. The element chlorine exists in nature as chloride salts of calcium, magnesium, potassium, and sodium. Chlorine gas (Cl_2), which is used for water purification, does not occur naturally but is manufactured from chloride salts. It is extremely reactive and unstable, and it combines with many of the same elements as oxygen. The non-reactive chloride is the form present in soils and is therefore the form that concerns agriculture.

CHLORINE REACTIONS IN SOILS

Virtually all of the chlorine in soil occurs as the soluble chloride ion (Cl^-). Chloride is not strongly associated with either soil minerals or organic matter and therefore exists primarily in a dissolved form in the soil solution. Chloride salts accumulate in saline soil. The availability of chloride to plants is influenced very little by soil acidity, aeration, or organic matter except as these factors affect the growth of plant roots and their ability to extract nutrients in general.

CHLORINE DEFICIENCY AND TOXICITY

Chlorine deficiency is rare in the United States and non-existent in Wisconsin. Manure contains approximately 5–10 lb/ton of chlorine as chloride. The use of muriate of potash (KCl) to supply potassium to farm fields adds 0.9 lb of chloride for each pound of potassium. Response to added chloride has been observed in Oregon, North Dakota, and South Dakota, but these areas are naturally very high in potassium, so little potash fertilizer is added. Some studies have shown a reduction in root rot of small grains with chloride additions.

Plants take up chlorine as the chloride ion (Cl^-), which the plants require for certain photo-chemical reactions in photosynthesis. Chlorine uptake affects the degree of hydration of plant cells and balances the charge of positive ions in cation transport. When chlorine is deficient, plants wilt more readily, lateral roots branch excessively, and "bronzing" of leaves can occur.

Chlorine toxicity results from an excessive application of chloride salts or the presence of high chloride levels in irrigation water. The latter is a serious problem in semi-arid areas, but not in Wisconsin. Some saline soils have naturally high chloride levels because there has been insufficient rain to leach the chloride out of the root zone. In Wisconsin, chloride toxicity only results from application of high rates of sodium chloride as a de-icing agent on highways and sidewalks, excessive applications of waste materials or fertilizers high in chloride, or fertilizer spills. Chloride is just one contributor to the toxicity, however; the associated cation is equally responsible. Although true toxicity results from plant accumulation of excess chloride, more often the "salt effect" occurs where soil water contains such a high concentration of dissolved substances that plants cannot obtain enough water, thereby causing the plants to wilt. This effect is not specific to chloride but is a cumulative effect of all ions and dissolved molecules present in the soil solution.

DIAGNOSTIC TECHNIQUES

Soil Analysis

No soil test interpretations for chloride have been developed for Wisconsin because the likelihood of deficiency is extremely small. Simple extraction of soil samples with water should give a good picture of soil chloride levels.

Plant Analysis

The optimum level of chloride is unknown for most plants. Hence, there are few criteria available for evaluating the results of a chloride analysis of plant tissue. Healthy crops usually contain 70–100 ppm chlorine on a dry weight basis, but may contain 20,000 ppm without adverse effects.

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)

Author: E.E. Schulte is professor emeritus of soil science, College of Agricultural and Life Sciences, University of Wisconsin-Madison and University of Wisconsin-Extension, Cooperative Extension. The author wishes to thank L.M. Walsh, dean emeritus and professor emeritus of soil science, University of Wisconsin-Madison for an earlier edition of this publication. Produced by Cooperative Extension Publications, University of Wisconsin-Extension.

This publication is available from your Wisconsin county Extension office or from Cooperative Extension Publications. To order, call toll free 877-947-7827 (WIS-PUBS) or visit cecommerce.uwex.edu.

A3556 Soil and Applied Chlorine RP-08-2004-(I 09/92)