A3555

Understanding Plant Nutrients

Soil and Applied Molybdenum

E.E. Schulte

Molybdenum (Mo) was identified as an essential element for higher plants in 1939. Most crops require less than 1 part per million (ppm) of this element—the lowest concentration of any essential nutrient. Soils contain about 0.25–5.0 ppm total molybdenum. It is found in trace amounts in the mineral olivine, in some iron and aluminum oxides and hydroxides, and in clay silicates.

MOLYBDENUM REACTIONS IN SOILS

In acid soils, iron and aluminum hydroxides strongly hold molybdenum; calcium compounds in calcareous soils do not. Therefore, molybdenum availability continuously increases as soil pH increases. In some cases, liming alone is sufficient to correct molybdenum deficiency. Soils derived from sands tend to be low in molybdenum content, while soils derived from shale and granite tend to have higher levels. Molybdenum availability is also generally higher in young volcanic soils and in soils high in organic matter.

Plants take up molybdenum as the molybdate ion ($MoO_4^{=}$). High levels of sulfate ($SO_4^{=}$) can suppress its uptake, possibly by ion antagonism.

MOLYBDENUM DEFICIENCY AND TOXICITY

Molybdenum deficiency occurs most often on acid, sandy soils and highly weathered soils. Leguminous crops and some vegetables are more likely to respond to molybdenum than are small grains and other grasses. In Wisconsin, yield response to molybdenum by red clover, soybean, and canning peas was observed on an acid (pH 5.1) Vilas sand; by lupine, red clover, and canning peas on Antigo stony loam (pH 5.1–5.7); and by canning peas on an Ella loamy sand (pH 5.3). Crops grown on fibrous peats and very acid soils in Michigan have shown positive yield responses to molybdenum additions.

Excess molybdenum is more likely to be a problem with animals than with plants. Concentrations exceeding 10 ppm are not toxic to plants, but ruminants feeding on plants with this much molybdenum are apt to develop molybdenosis, an antagonism of molybdenum on copper metabolism. Dietary copper supplementation adequately overcomes this problem.

FERTILIZER SOURCES OF MOLYBDENUM

Table 1 lists the common molybdenum fertilizer materials. Before applying molybdenum, check the soil pH. Liming to a pH of 6.0 or higher may be sufficient to correct a deficiency. If fertilizing is necessary, seed treatment of 0.5 oz/a is usually adequate because of the small amount of molybdenum required. Foliar sprays at rates of 2–3 oz/a of sodium molybdate or ammonium molybdate are effective on growing crops when molybdenum deficiency is identified.

DIAGNOSTIC TECHNIQUES

Deficiency Symptoms

Molybdenum is required for nitrogen fixation by leguminous plants and for conversion of nitrate to organic nitrogen by all plants. Hence, the first symptom of molybdenum deficiency is expressed as nitrogen deficiency. If the deficiency is severe, the leaf edges of some vegetable crops may become brown and curl upward (cupping). Cupped leaves may look rolled and show interveinal chlorosis. Molybdenum deficiency in cauliflower leads to a classic condition known as whiptail, in which leaves sometimes appear crinkled or withered. Broccoli, cauliflower, lettuce, onion, spinach, and table beet are responsive to this element; corn, small grains, and potato are not.

Soil Analysis

Because of the low incidence of molybdenum deficiency and because most soils have been limed above pH 6.0, no reliable soil test for this element has been developed for use in Wisconsin.

Table 1. Fertilizer sources of molybdenum.

SOURCE	FORMULA	PERCENT MOLYBDENUM
Ammonium molybdate	$(NH_4)_6Mo_7O_{24}\cdot 2H_2O$	54
Molybdenum trioxide	MoO_3	66
Sodium molybdate	$Na_2MoO_4\cdot 2H_2O$	39

Plant Analysis

None of the Wisconsin plant-analysis laboratories routinely analyzes plant tissue for molybdenum. Table 2 provides some guidelines for interpreting molybdenum analyses, but precise limits for deficiency and toxicity are not well known.

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. Molybdenum plant-analysis interpretations for common Wisconsin crops.[a]

			INTERPRETATION		
CROP	**PLANT PART SAMPLED**	**TIME OF SAMPLING**	**LOW**	**SUFFICIENT**	**HIGH**
			ppm		
Alfalfa	Top 6 inches	Early bud	<1.0	1.0–5.0	>5.0
Corn	Earleaf	Silking	<0.1	0.1–2.0	>2.0
Potato	Top leaves	Flowering	<0.5	0.5–4.0	>4.0
Small grains	Top leaves	Boot stage	<0.03	0.03–5.0	>5.0
Soybean	First trifoliate	Early flower	<1.0	1.0–5.0	>5.0
Vegetables	Top fully developed leaf	Midseason	<0.5	0.5–5.0	>5.0

[a]*From Robertson et al. 1981*. Molybdenum: An essential plant nutrient. *Michigan State University Extension*

Author: E.E. Schulte is professor 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 P.D. Ehrhardt for editorial assistance. Produced by Cooperative Extension Publications, University of Wisconsin-Extension.

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