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Fact sheet

Manganese

Needs of Soils and Crops in New Jersey

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Function of Manganese in Plants

The most well known function of manganese in green plants is involvement in the splitting of water to release oxygen during photosynthesis. Manganese also functions as part of plant enzyme systems. In some metabolic reactions manganese (Mn) can replace magnesium (Mg).

Manganese Deficiency Symptoms

In manganese deficient plants, photosynthesis is impaired and chloroplasts in the leaf tissue do not function properly. Because manganese is immobile in the plant, deficiency symptoms appear first on younger leaves. Symptoms vary among plant species but typically there is a decrease in leaf chlorophyll content and green color. "Interveinal chlorosis" (yellowing between the veins while the veins remain green) is a common symptom in manganese deficient crops such as soybean, alfalfa, corn, and strawberry.

When symptoms are not severe, the young leaves may exhibit only a slight loss of color between the veins. In extreme cases the leaves may turn nearly white. Plant growth will be stunted depending on the severity of the deficiency. In oats and other small grain crops, manganese deficiency is described as "gray-speck" where there are whitish-gray spots, flecks, or strips on the leaves.

Other nutrient deficiencies or herbicide damage can also cause plants to exhibit interveinal chlorosis. To separate a true manganese deficiency from other crop maladies, consider diagnostic information provided by soil pH measurement, soil and plant analysis, and field history.

Occurrences of Manganese Deficiency

Manganese deficiency is a common and recurring problem on many sandy soils in southern New Jersey but the deficiency rarely occurs on the finer textured soils in northern New Jersey. The coarse textured soils of the Atlantic Coastal Plain region of the United States are often low in manganese content. When these soils receive heavy applications of lime, manganese deficiency often results. The occurrence of manganese deficiency also varies depending on the crop being grown (Table 1)

Plant Tissue Analysis

Analysis of leaf tissue gives a good indication of manganese nutritional status. Tissue analysis also helps determine whether manganese is in balance with other nutrients, or if it is present in excessive amounts.

Sampling procedures vary with growth stage and crop species. In general, sample mature leaves just below the growing tip on main branches or stems.

Depending on the crop, the minimum manganese sufficiency levels are in the range of 15 to 25 ppm Mn in dried leaf tissue. Mature normal leaves may have concentrations of up to 200 ppm. Leaf concentrations above 400 ppm Mn may be toxic.

Table 1: Sensitivity of plants to low levels of available manganese (Mn) in soil[1].

Susceptible	Moderately Tolerant	Tolerant
Alfalfa	Corn	Rye
Soybean	Barley	
Oats	Potatoes	
Wheat	Fruit Trees	
Onions	Broccoli	
Spinach	Celery	
Lima Beans	Cucumber	
Radish	Peas	
Raspberry	Tomato	

[1]Varieties of given crop may differ significantly in sensitivity or tolerance to low levels of available Mn.

Soil Analysis

Soil tests are effective ways to identify manganese deficient soils. Interpretation of soil analysis for manganese (Table 2) is based on a combination of soil pH measurement and the level of Mehlich-1 or Mehilich-3 extractable manganese. Soil test reports from the Rutgers Soil Laboratory classify the availability of manganese as "low," "adequate," or "high." Depending on the crop, soils with a low rating are likely to need manganese fertilizer. Soils with an adequate rating generally do not need manganese fertilization. Soils with a high rating clearly do not need manganese fertilization and, depending on the crop and soil pH, may need lime to reduce manganese availability.

Factors Affecting Manganese Availability

Soil pH: Manganese solubility is strongly influenced by soil pH. As soil pH increases, manganese availability decreases. In very acid soils, excessive levels of manganese can be toxic to plants. Raising the soil pH with lime alleviates manganese toxicity.

On coarse-textured soils that are prone to manganese deficiency, lime recommendations need to be followed carefully to avoid overliming. On soils that are low in manganese, the target soil pH for liming should not exceed 6.2 for crops that are very susceptible to manganese deficiency, such as soybean and wheat.

Table 2: Adequate levels of soil test manganese for Mehlich-1 or Mehlich-3 soil test extractants[1] at different soil pH levels.

Adequate levels of extractable Manganese	Adequate levels of extractable Manganese	Manganese fertilization usually recommended when soil pH is equal or greater than
Mehlich-1 Mn, ppm	**Mehlich-3 Mn, ppm**	**Soil pH**
0.2 – 1.6	0.2 – 1.3	5.1 – 5.3
1.7 – 3.1	1.4 – 2.6	5.4 – 5.6
3.2 – 4.6	2.7 – 3.8	5.7 – 5.9
4.7 – 6.1	3.9 – 5.0	6.0 – 6.2
6.2 – 7.6	5.1 – 6.2	6.3 – 6.5.
7.7 – 9.1	6.3 – 7.4	6.6 – 6.8
9.2 – 10.2	7.5 – 8.3	6.9 – 7.1

[1]The Rutgers University Soils Laboratory performs the Mehlich-3 soil test.

Aeration: The lack of oxygen in waterlogged soils increases manganese solubility. Long periods of water logging in low-lying areas of a field may cause manganese to leach out of the soil.

Organic Matter: Reactions with organic matter influence manganese availability. Sandy soils that are above pH 5.6, high in organic matter, and have a tendency to become waterlogged are frequently manganese deficient.

Additions of organic materials such as crop residues, manures, or compost may also increase manganese availability.

Interactions with Other Nutrients: Excess levels of copper, iron, or zinc in soil increase the potential for manganese deficiency. The application of potassium chloride fertilizer tends to increase manganese availability.

Nitrogen Source: The use of ammonium fertilizers, such as ammonium sulfate, favors soil acidification and improves manganese availability.

Soil Microorganisms: Soil microorganisms that oxidize soluble manganese to unavailable forms are more active when the soil pH is near 7.0. Some of these microorganisms are pathogens that cause take-all disease on wheat and on bentgrass.

Manganese Fertilizers

Manganese sulfate ($MnSO_4$) is a widely used fertilizer for soil or foliar treatment of manganese deficiency (Table 3). Chelated manganese (MnEDTA) is commonly used for foliar treatment but it is not as effective as manganese sulfate when applied to soil. Manganese oxides have a low solubility and are less available for plant uptake.

Table 3: Source of fertilizer manganese (Mn).

Source	Formula	% Mn
Manganese sulfate	$MnSO_4 \cdot 3H_2O$	26 – 32
Manganese chloride	$MnCl_2$	17
Manganese chelate	MnEDTA	5 - 12

Manganese Rates for Soil Application

Manganese deficient soils rapidly convert fertilizer manganese to unavailable forms. Manganese sulfate is the preferred fertilizer source for soil applications. Banded applications are more effective than broadcast applications. Applying an ammonium nitrogen fertilizer with banded manganese improves its availability. Recommended rates for broadcast application are 20 to 25 lbs Mn/acre and for band application 5 lbs Mn/acre.

Manganese Rates for Foliar Application

Foliar applications of manganese are generally more economical and effective than soil applications. Manganese deficient plants usually respond quickly to foliar treatment with improved leaf color. Depending on the severity of the deficiency, foliar applications of manganese may need to be repeated two or more times during the growing season.

When manganese sulfate is foliarly applied, recommended application rates are 0.5 to 2 lbs Mn/acre. Refer to the product label for application rates of chelated manganese. Application rates of chelated manganese greater than 0.25 lbs Mn/acre may cause phytotoxicity in some plants.

Specific recommendations for correction of manganese deficiency in alfalfa and soybean are provided in Rutgers Cooperative Extension Fact Sheets FS632 and FS568.

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