IPNI Plant Nutrition TODAY
Better Crops, Better Environment...through Science

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MANGANESE IN CROP NUTRITION

Manganese (Mn) was first shown to be an essential plant nutrient in 1922. It is needed in only small quantities by plants, and like other micronutrients Mn is ultimately as critical to plant growth as are the major nutrients.

Mn in plants. Manganese is taken up from soils in the Mn^{2+} form, and in organically complexed forms. Plant roots release exudates such as low molecular weight organic acids that aid in Mn uptake from the soil. Manganese is rather immobile in plants. This is an important point because it means that deficiency symptoms will first appear on younger leaves since the plant cannot easily scavenge Mn from older tissue. The normal concentration range of Mn in plants is typically from 20 to 300 ppm—below 15 to 20 ppm deficiency occurs.

Within plants, Mn functions mostly as an activator in enzyme systems, and is also a constituent of certain enzymes. It is essential to photosynthesis, and catalyzes the water splitting reaction within plants. The synthesis of lignin, which adds strength and stiffness to cell walls, is dependent on Mn. Lignin is considered an important component in the defense against pathogens, and where Mn is deficient plants may be less resistant, especially to root-infecting pathogens. A notable example of this is with take-all root rot in wheat, where in some studies Mn fertilizer has been reported to limit take-all if used before the onset of foliar symptoms.

Some crops are more sensitive than others to Mn deficiency. Sensitive crops include soybeans, small grains, peanuts, cucubits, onions, peas, radishes, and beans.

Mn in soils: The earth's crust is about 0.11% Mn. Total Mn in soils generally ranges from about 20 to 3,000 ppm (0.002 to 0.30%), but only a fraction of this total is plant available. The most common form of Mn in soil solution is Mn^{2+}, which is often complexed by organic compounds.

The concentration of Mn^{2+} in soil solution is highly pH dependent, with levels theoretically decreasing by 100x with each unit of pH increase. Thus, plant available Mn increases as soil pH decreases, so deficiencies are more likely to occur in alkaline and alkaline calcareous soils. On the other extreme, if soil pH is too low (<5) Mn can become toxic to sensitive crops.

Crop deficiencies of Mn occur most often on high pH (alkaline) soils, and on soils that are simply naturally low in Mn. Deficiencies may also be problematic in high organic matter soils such as peats and mucks that favor the formation of unavailable Mn chelates. It should be noted too that high levels of copper, iron, or zinc may reduce Mn^{2+} uptake. The most common extractant used in soil analysis for Mn is the chelating agent DTPA. The critical level for DTPA extracted Mn is usually set at 1 ppm, but this may vary depending on local calibration research.

Manganese sulfate ($MnSO_4$) is the most common of the Mn fertilizer sources. It is highly water soluble and suited for soil or foliar application. There are several other Mn fertilizer sources including chelates, chlorides, oxides and oxysulfates. Manganese fertilizer can be applied broadcast, banded or as foliar spray. Rates of Mn application are highly dependent on method of application. Soil applied broadcast rates generally range from about 10 to 15 lb Mn/A, banded near the crop row ranges from about 3 to 5 lb Mn/A, and foliar application usually ranges from about 1 to 2 lb Mn/A.

For more on Mn and other plant nutrients see IPNI's new Nutri-Facts series online at http://www.ipni.net/nutrifacts.

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