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JOHN'S CORNER:

MINERALS - The Elements and What They Do (Part 17)

by John Ferguson

25) Manganese (Mn) - Manganese is a metal found in group 7 of the periodic table of elements. Manganese is a hard brittle silvery metal that will burn in oxygen and react with water. The most common electrical state for manganese is +2 and it combines easily with other elements and is a component of hundreds of minerals.

Manganese can be found in igneous rocks at 950 ppm, shale at 850 ppm, limestone at 1,100 ppm and sandstone at 50 ppm. In most soils, it is around 850 ppm but is not often found in water, with fresh water having only 0.01 ppm and seawater even less.

One of the first uses for manganese was in its black oxide form, it was found in cave paintings from over 17,000 years ago where it was used to make a black paint. Manganese is very useful when mixed with iron (Fe) to form alloys that form high quality steel that can take a very sharp edge as in razors. Manganese is used in many items from baseball bats to golf clubs, from fuel additives to batteries. Potassium permanganate ($KMnO_4$) is a strong oxidizing agent used by water systems and creates an intense pink color when dissolved in water.

Manganese became famous by the efforts of the CIA to recover a sunken Russian submarine under the guise of mining manganese nodules from the ocean floor.

Manganese is essential for all living beings. It activates enzymes involved with glucose metabolism, energy production, and superoxide dismutase. It is a component of several metalloenzyme's, hormones and human proteins.

However, excess manganese in water systems and in some industrial processes can produce a Parkinsonian like syndrome and psychiatric disorders that resemble schizophrenia.

Manganese is used to strengthen nerves and involved with their correct functioning. Manganese is involved with amino acid, lipid, and carbohydrate metabolism and is used as a co-factor in many enzymes. Excess manganese prevents the body from absorbing iron (Fe).

Deficiencies of manganese are linked to birth defects, asthma, convulsions, retarded growth, skeletal defects, and disruption of fat and carbohydrate metabolism, to joint problems. The best-known deficiency disease is carpal tunnel syndrome where tens of thousands of surgeries and numerous devices are sold to correct a simple nutritional deficiency. Manganese is used to make the molecule mucopolysaccharides which is used in collagen, bone and cartilage.

Animals are more sensitive to manganese deficiencies than humans are.

Nuts, chocolate, cereal based products, sugar beets and some fruits are good sources of manganese along with snails (think French cuisine).

Gardening and Landscaping Problems Associated with Manganese (Mn)

Manganese is mobile in most soils and in conditions of high humidity. Acid conditions leads to manganese being leached from soils.

Some microbes (bacteria and fungi) help precipitate magnesium out of the soil solution by changing its common oxidative electrical state from +2 to +3 or +4 which then changes its chemical properties. Biological properties of the soil are critical for manganese utilization by plants. All manganese compounds are important as they are essential for plant nutrition and they control the behavior of many other trace elements. Microbes are essential for cycling manganese in terrestrial systems.

It is interesting that sterilizing soils in greenhouse applications has lead to manganese toxicity; the microbes also prevented the plant from absorbing too much.

Adequate manganese helps promote calcium (Ca) availability in the soil and is necessary for all plants. Uptake by plants is done passively and by microbial action. The interaction between

roots and microorganisms can result in the oxidation of the available form of manganese (Mn^{+2}) into an unavailable form (Mn^{+3} or Mn^{+4}) as mentioned above. Manganese deficiency can occur on calcareous soils due to its alkalinity.

Research at Purdue University has found that the application of the glyphosate-based herbicide Round-Up, will tie up manganese within the soil and the plant, and alter the microbial populations in the rhizosphere. Note: Several researchers believe this also happens in human digestive systems when we eat food grown and treated with glyphosate, preventing one from absorbing any manganese that might have been present which then leads to numerous health problems like carpal tunnel.

Manganese is easily transported in plants, but tends to accumulate in older leaves and sheaths. Manganese is required for the plant enzymes arginase and phosphotranferase and may substitute for magnesium (Mg) in other enzymes. Manganese is involved with photosynthesis and the oxygen transport system. It is used in reducing nitrogen oxide ions (NO_2^-) during the reduction process hence; it is believed to affect the nitrogen assimilation process.

For years, gardeners were told to use Mn EDTA (manganese ethylrnedaminetetraacetic acid) to correct manganese shortages. We now know this chemical actually made the deficiency worse as it induced more manganese deficiency.

Manganese is a micronutrient and plant tissue contains 5-500 ppm depending on the species. It is required for certain physiological processes such as enzyme and co-enzyme systems, and activates enzymes used in the growth process. It aids in the oxidase enzyme in carrying oxygen and enters into oxidation and reduction reactions needed in carbohydrate metabolism. Manganese is required for seed formation and involved in the production of chlorophyll.

A deficiency results in poor uptake of other nutrients resulting in mineral imbalances in plant tissues. Symptoms frequently resemble iron deficiency and if there is excess sodium and potassium (10% or more of available nutrients) manganese will not reach the plant. Deficiency shows up on youngest leaves and stems, high pH soils, sandy soils, low organic matter soils, overly limed soils, and is seen as interveinal chlorosis.

Manganese deficient plants have retarded growth, lower resistance to disease and pests, and increased sensitivity to climate issues. This includes reduced cold hardiness. The most common symptom of manganese toxicity is iron (Fe) chlorosis and brown spots on leaves with browning of roots on some plant species. Excess manganese also prevents plants from absorbing cobalt (Co).

Excess phosphorous (P) in artificial fertilizers can cause or aggravate manganese deficiencies. Manganese toxicity occurs on soils with a pH of 5.5 or less (acid) on soils with lots of manganese and on poorly drained soils. Activities of some enzymes and hormones of plants are reduced with exposure to excess manganese. Many legumes will not fix nitrogen if there is too much manganese.

Deficiencies can be corrected by both soil and foliar applications of manganese.

Note: Sewage sludge (Biosolids) is often a source of manganese toxicity.

Sources: compost, native mulches, manganese sulfates, chelates of manganese, basalt sand.