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Manganese for Kentucky Turfgrasses

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Manganese (Mn) is a common component of micronutrient packages applied to turfgrass and has been documented to result in increased greening of turfgrass. In order to effectively manage Mn applications, it is important to understand the function of Mn in turfgrass, the dynamics of Mn in the soil, and the various forms of Mn available for turfgrass applications.

Function of Manganese

Manganese serves several roles in turfgrass. Strong evidence suggests that Mn undergoes a series of oxidation steps during photosynthesis that are required for H_2O oxidation and the generation of O_2. Manganese is a cofactor of numerous enzymes that are required for various plant functions. In the absence of Mn, the structures required for photosynthesis (thylakoids) may collapse, resulting in a loss of green color and a rapid reduction in photosynthesis. If Mn deficiency persists, turfgrass leaves may exhibit interveinal chlorosis on the younger leaves, similarly to iron deficiency.

Soil Manganese

In order for the turfgrass to uptake Mn from the soil solution, the Mn must be soluble. Manganese becomes more soluble as pH is reduced and may become insoluble as pH is increased, especially following an application of lime. The application of organic matter can reduce Mn availability because Mn may become bound into the organic matter complex. However, this dynamic depends on the type and decomposition state of the organic matter. Less decomposed organic matter, such as peat moss and compost, may result in greater Mn availability because the Mn may be bound into soluble organic chelates rather than less soluble organic complexes.

Because most Kentucky soils are acidic (pH<7.0), Mn deficiency in turfgrass is uncommon. However, on golf course putting greens and sand-capped sports fields, soil pH may exceed 7.0. In these scenarios, Mn deficient turfgrasses are common. Manganese deficiency may be cured by directly applying Mn. In situations where the soil pH is > 7.0 and urea is the primary nitrogen source, exchanging urea with ammonium sulfate will reduce the soil pH and has been documented to cure Mn deficiency. To this end, additional applications of Mn are not necessary.

Soil Testing

Limited evidence exists indicating that bentgrass grown on soils with < 30 ppm Mehlich-III Mn may be prone to take-all patch caused by *Gaeumannomyces graminis*. However, caution should be taken when applying Mn based upon this soil test level because the ability of Mn to reduce the risk of take-all patch has not been confirmed on Kentucky soils. Most soil testing laboratories do not test for nor provide a fertilizer recommendation for Mn. In many respects, Mn is similar to iron in that the oxidation state changes quickly based upon soil pH, soil moisture, soil temperature, etc. For this reason, providing a soil test recommendation to apply or not apply Mn is not well correlated to a turfgrass response. In addition, soil test calibrations used to predict a turfgrass response to the application of Mn have not been established on Kentucky soils.

Tissue Testing

Tissue testing can determine the Mn concentration of the turfgrass leaves at the time of sampling but, similar to soil testing, tissue testing is not a reliable method to manage Mn applications to turfgrasses. In order for Mn tissue testing to be useful, a pre-determined Mn concentration must be determined within healthy turfgrass so that we know what the "normal" Mn concentration should be. Current research has clearly shown that Mn concentrations within healthy turfgrass fluctuate based upon season,

Figure 1. Putting green showing a greening response to the application of granular Mn sulfate applied at 2 pounds of Mn per acre per month.

N fertility, and species, to name a few. Therefore, until the Mn concentration in turfgrass tissue is properly correlated and calibrated to a turfgrass response, using tissue tests to apply Mn is not a best management practice.

Applying Manganese

Granular Applications

Granular applications of Mn can be the least expensive method of curing Mn deficient turfgrass. The application rate of Mn is not well documented. However, the rate will likely vary depending upon the location (i.e. putting greens, lawns, sod production, etc.). On putting greens, a rate of 2 pounds of Mn per acre per month has been shown to increase turfgrass greening (Figure 1). Higher application rates near 20 pounds of Mn per acre per month may be required in other turfgrass areas. If Mn sulfate is applied to putting greens, a particle size of 100 SGN (size guide number) or less is recommended to allow the particle to move through the turfgrass canopy to the soil. Larger particle sizes are less expensive and are more appropriate for higher cut turfgrass such as roughs, fairways, lawns, and sports fields. In these locations, granular Mn may be applied with your normal nitrogen fertilizer. To determine the amount of Mn applied in blended fertilizer, use the following calculation:

Pounds of fertilizer applied per acre × the % Mn = pounds of Mn per acre

As an example, any blended fertilizer applied at 300 pounds per acre that contains 2 percent Mn would be applying 6 pounds of Mn per acre.

Foliar Applications

Foliar Mn applications result in a more uniform distribution of Mn across the turfgrass than granular applications. This benefit is often most valuable on putting greens, where a turfgrass response is magnified. However, this does not necessarily imply that foliar Mn applications are more valuable than granular. In current research trials, when Mn was applied as Mn sulfate in either granular or foliar form, turfgrass responded more consistently to granular Mn.

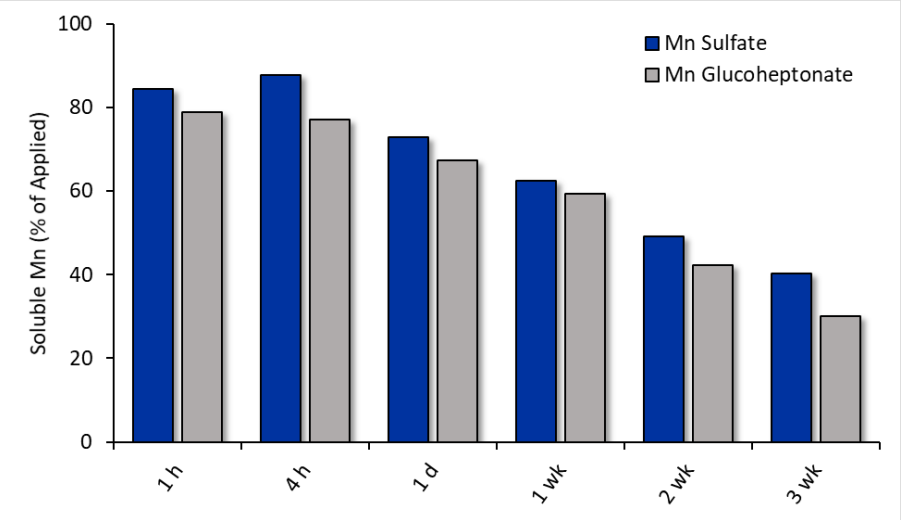

Figure 2. Manganese may remain soluble for several weeks in soils. The inclusion of the organic chelate (glucoheptonate) does not increase Mn solubility.

Manganese Sources

Manganese Sulfate

Managanese sulfate is the most common source of Mn for turfgrasses for both granular and foliar applications. Granular Mn sulfate is normally a round, white particle and is available in micro particle sizes for putting greens up to larger particle sizes for lawns and golf fairways. Manganese sulfate used as a foliar application should be limited to "sprayable" or "spray grade" Mn sulfate. This should not be confused with soluble Mn sulfate. Sprayable Mn sulfate is soluble, but soluble Mn sulfate may not be sprayable due to potential contaminants that may clog spray nozzle screens. Upon contact with moist soil, about 20 percent of the Mn in Mn sulfate becomes unavailable within the first hour because the Mn oxidizes when it comes into contact with water. The remaining Mn may remain plant available for several weeks (Figure 2). If oxidation occurs on surfaces such as sidewalks or cart paths, a reddish-brown stain may occur.

Manganese Oxides

Manganese oxysulfates, sucrates, and frits contain a component of Mn oxide. Manganese oxides are normally dark brown or black in color and may be either round or angular. The majority of Mn in Mn oxide fertilizers is unavailable for turfgrass uptake because the soluble Mn form (Mn^{2+}) has already been oxidized. Thus, Mn oxides are generally considered inefficient Mn sources.

Manganese Chelates

Chelates increase the solubility of metal and, in turn, the quantity of the metal available for plant uptake. Numerous Mn chelates exist in both granular and foliar forms. Some organic chelates have been shown to provide no increase in soluble Mn compared with Mn sulfate (Figure 2), whereas the synthetic chelate Mn EDTA can increase soluble Mn in the soil solution. However, broadcast applications of Mn chelates to soil are not normally recommended because the Mn in the chelate is easily replaced with Ca and/or Fe from the soil. If this occurs, the chelated Ca may exacerbate any Mn deficiency. To this end, chelated Mn should be used with caution or not at all.

Summary

Manganese plays a vital role in turfgrass growth. Turfgrasses grown on native Kentucky soils do not normally require additional applications of Mn. However, if Mn deficiency is determined, Mn applied as Mn sulfate at a rate of 2 pounds of Mn per acre per month can alleviate Mn deficiency. On high pH soils, using ammonium sulfate can lower pH and alleviate Mn deficiency without the need to purchase and apply additional Mn.

References

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