Free call 1800 644753 Telephone: +61 2 4729 2888
Facsimile: +61 2 4729 2810 Email: jspencer@paton.com.au
Internet: www.paton.com.au

The Role of Mn

As is the case with Zn, the literature on Mn use by turf is not extensive. Turner and Hummel (1992) summarized the few reports on Mn content in several turfgrasses and found that the values varied widely among grass species and between laboratories.

The Mn content of dried clippings reported by Waddington and Zimmerman (1972) for seven turfgrasses averaged 297 mg/kg (ppm) while that reported for another seven turfgrasses by Butler and Hodges (1967) averaged only 46 mg/kg. Waddington and Zimmerman (1972) were concerned about these differences and compared the Mn content of creeping bentgrass leaves on several dates throughout a growing season. They found the Mn content ranged from 163-391 mg/kg. These differences could reflect the fact that Mn is not readily redistributed in plants so it pretty much remains in those leaves into which it is delivered by xylem transport from the roots.

During times of slow shoot growth, Mn would have more time to accumulate in leaves before they were sampled for analysis. Variation between analytical laboratories could reflect differences in methods utilized or differences in the amount of Mn available to the turf (sand vs. soil based greens). Jones (1980) concluded that a Mn sufficiency range for turfgrasses was between 25-50 mg Mn/kg dry leaf tissue. The critical Mn concentration (plant tissue concentration that will support 90% of maximum growth rate) generally ranges from 10 to 20 mg Mn/kg dry weight (Marschner 1995). This makes the turfgrass requirement for Mn about the same as that for zinc.

Soil manganese

Manganese is a reasonably abundant element with an average concentration in the earth's crust of 1000 ppm and a soil range of 20-3000 ppm averaging about 600 ppm being much more soluble and available to plants in acid soils (pH < 5.5).

However, for free Mn^{2+} to be released into the soil solution and occupy cation exchange sites, reducing power in the form of organic matter must be available.

$$MnO_2 + 4H^+ + 2e^- \longleftrightarrow Mn^{2+} + 2H_2O$$

Here, minerals containing Mn in oxidized form (Mn^{3+} or Mn^{4+}) will be reduced to Mn^{2+} by acquiring electrons (e^-) through the microbial oxidation of organic carbon.

In acid soils, soluble Mn may exceed acceptable levels by substantial amounts and become toxic to plants. This is likely in situations where soil minerals contain Mn, the organic matter content is high, the pH is low and the soil is periodically waterlogged (low in free oxygen). Under such conditions, acid inhibition of plant growth may be due primarily to toxic levels of available Mn.

Under opposite conditions (parent minerals low in Mn, alkaline pH, low organic matter and good drainage) inadequate supplies of available Mn are likely.

Functions of manganese

Manganese serves a number of functions in plants with its most important roles are as an essential component of the oxygen (O_2)

evolving complex in photosynthesis and as an activator cofactor of several major enzymes involved in numerous metabolic sequences. Manganese also plays a role in root elongation and lateral root initiation possibly by regulating the auxin levels along the root axis. Some of these functions that are most significant for turfgrass performance will be discussed in this section.

Manganese deficiency and toxicity

The most common turf response to inadequate Mn is a markedly reduced growth rate of both shoots and roots. Increased disease incidence is another symptom of Mn deficiency. Because Mn plays many critical roles in the biosynthesis of phenolics and lignin, grasses deficient in Mn are unable to respond to pathogen attack by producing phytoalexins that would inhibit spore germination and block fungal invasion. As a result, disease out-breaks are more frequent and difficult to control.

Many soil fungi that normally would not be pathogenic or only weakly so will cause disease in Mn deficient plants. This makes disease identification more difficult and reduces the effectiveness of fungicides. In short, the grass is unable to do its part in resisting infection and has no chance of growing out of an infection.

You might suspect that Mn supplies are low when turf receiving acid generating fertilizers exhibits less disease. Fertilizer materials such as (NH4)2SO4, NH4NO3 and urea tend to acidify the rhizosphere making Mn more soluble and available to grass roots. If liming promotes an increase in disease incidence, again you might suspect that Mn supplies are marginal.

Because Mn is not readily mobilized within a plant (it does not translocate well in the phloem), new leaf growth is most likely to become chlorotic when Mn is deficient. This symptom can easily be confused with that resulting from an Fe deficiency. Iron deficiency causes emerging new leaves to be bright yellow and continue growing at a reasonable rate.

Manganese insufficiency results in dull chlorotic leaves that do not grow rapidly. Soil conditions that would promote Mn deficiency (elevated pH, high organic matter and carbonate enrichment) would also tend to reduce the availability of Fe. However, deficiencies of Mn are less common in turf than are those of Fe.

Turf grown on soil may experience Mn toxicity. Any program that would acidify soils (NH4-fertilizers, sulphur sources) could make Mn increasingly available and reach toxic levels. As mentioned above, Mn toxicity is part of the acid soil toxicity syndrome but this can usually be avoided by maintaining the soil at pH 5.5 or higher.

Turf grown on artificial media (sand based greens) is prone to suffer from inadequate Mn unless it is applied in fertilizer or top dressing. The materials from which artificial greens are constructed will contain very little Mn and sufficient amounts will not likely be provided as contaminants in fertilizers or most other soil amendments. Thus, Mn should be considered as part of a micronutrient management program.

Sources of manganese

When a Mn insufficiency is suspected, it should by confirmed by a tissue test to determine if it is approaching the critical concentration of 25 ppm. If an addition of Mn is indicated, there are several sources available. The material most widely used for the correction of Mn deficiency is $MnSO_4 \cdot 4H_2O$. It can be applied through the soil or as a foliar spray. MnO is largely insoluble but it can be used effectively as a Mn source if ground finely and incorporated throughout the root zone. There are a number of natural organic Mn complexes and synthetic Mn chelates that are effective sources of Mn when applied as a foliar spray.

Because Mn will not translocate from leaves to perennial plant organs, several foliar applications may be needed to provide season-long benefits. Frequent mowing and clipping removal will reduce the effectiveness of foliar applications to greens or other intensively managed turf. For such areas, Mn and other micronutrients should be incorporated into a comprehensive turf management program. This could involve an application of Mn with selected pesticide treatments, top dressings, syringings or other appropriate opportunities throughout the season.

On sand-based greens, Mn immobilization within the root zone should not be a problem and less expensive granular Mn sources can be applied during aerification or when the turf is being established.

Broadcast topical applications can be made to established turf and incorporated via irrigation.

As turf is managed ever more intensely, the chances of micronutrients becoming deficient increase sharply. For elements such as Mn, deficiencies are not easily detected and the turf manager can spend much time and effort trying to identify the cause of problems that are indirectly related to a nutrient deficit. To avoid such problems, a preventive approach might be best.

Micronutrient treatments are not costly and if applied properly rarely can cause injury. Thus, the management of Mn in turf might best be guided by the saying: an ounce of prevention is worth a pound of cure.