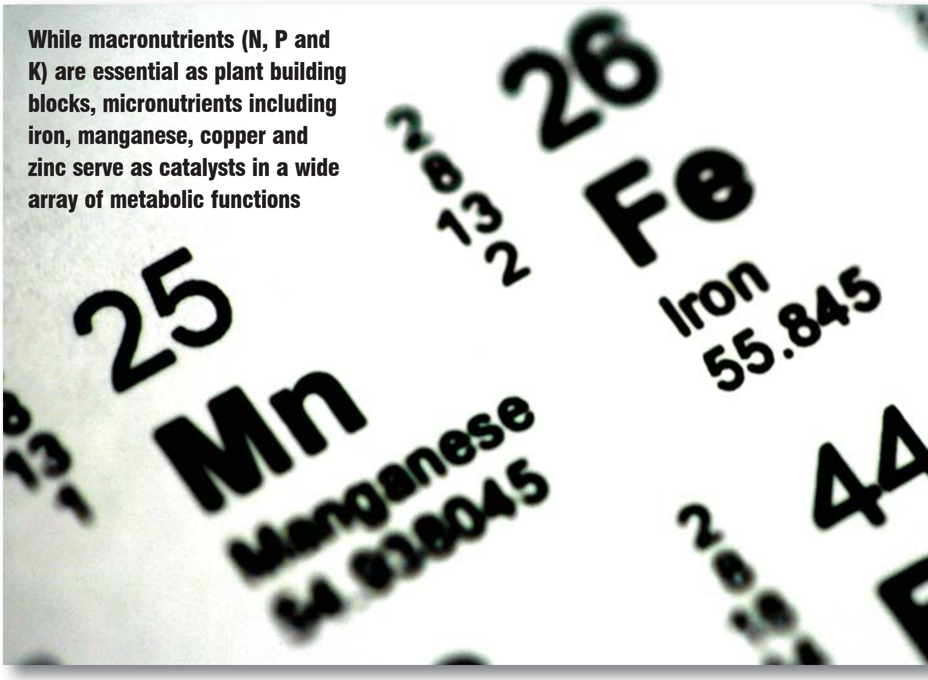

While macronutrients (N, P and K) are essential as plant building blocks, micronutrients including iron, manganese, copper and zinc serve as catalysts in a wide array of metabolic functions

Managing **micronutrients**

Trace elements are essential ingredients in the overall health of any turf species and managing their levels can be a delicate balancing act for turf managers. In this instalment of Tech Talk, AGCSATech senior agronomist Andrew Peart looks at four key micronutrients – iron, manganese, copper and zinc – and the important role they play in turf health.

Micronutrients, otherwise known as trace elements, are just as important as their well-known relatives the macronutrients (nitrogen, phosphorus and potassium). While macronutrients are essential as building blocks for amino acids, proteins, sugars and starches, micronutrients serve just as an important role as catalysts in a wide array of metabolic functions (Skorluski, 2003).

Elements that fall into the category of micronutrients include iron, manganese, zinc, copper, molybdenum, boron, chlorine and nickel. Most soils generally have adequate quantities of these as very little is required by the plant. However, highly leached sandy soils or those with an alkaline pH may be deficient in one or more of these elements.

Due to micronutrients only being required in small amounts, a build up of these elements can often cause more problems for turf rather than if they were deficient. High levels are likely to cause toxicity and as Beard (1973) states, manganese, zinc, copper and boron are most likely to produce toxic effects on turfgrasses at higher concentrations.

IRON

Iron is the micronutrient that is most commonly deficient in turf (Beard, 1973). However, the deficiency is usually caused as a result of the unavailability or insolubility of the element rather than an insufficiency or an absence.

The major function of iron is its involvement in the formation of chlorophyll. Iron is not a part of the chlorophyll, but chlorophyll will not be formed if iron is not there in sufficient quantities (Christians, 2007). Being heavily involved in the production of chlorophyll, an iron deficiency is expressed in the plant as chlorosis, or a yellowing of the leaf. The yellowing of leaves in iron-deficient plants occurs in the youngest actively growing leaves whereas a nitrogen deficiency, which can also result in a chlorotic appearance, will first be seen in the older leaves. The chlorosis can extend to the older leaves if the deficiency persists.

With severe iron deficiencies the blades become nearly white or ivory in colour in the advanced stages. Beard (1973) states that chlorosis commonly appears when the iron content of the tissue is below 50ppm (mg/kg).

Iron is an immobile element meaning there is very little movement from the older leaves to the newer leaves and therefore if there is a soil deficiency a constant supply of iron must be applied.

Deficiencies of iron can be caused by alkaline soils (pH>7.0), soils high in phosphate, manganese and zinc, severely thatched or waterlogged soils. Handreck and Black (2002) also state that high bicarbonate levels in the irrigation water can lead to an iron deficiency.

The most common remedy for an iron deficiency is through the application of a soluble iron product, such as iron sulphate or ferrous sulphate. On alkaline soils however, these types of applications must be intended to be absorbed through the leaf as it will quickly change to an unavailable from when it comes in contact with the soil. The other alternative to rectify iron deficiencies on alkaline soils is to apply iron in the form of an iron chelate.

Christians (2007) states that the dictionary defines the word chelate as 'claw' referring to the way in which the chemical chelating agent combines with the iron to hold the element and to improve its availability to the plant. The chelating agent is normally an organic compound that when combined with iron, or any other micronutrient, forms a stable organic complex that is readily exchanged with cations but has less tendency to leach or being transformed into unavailable compounds than the more water soluble sulphate form. Therefore, the other advantage it has over the sulphate form is it has a longer residual response in the soil.

MANGANESE

Manganese, like iron, has a major role in the formation of chlorophyll and plays a role in photosynthesis (Christians, 2007). Beard (1973) states that manganese availability in the soil is controlled to a great degree by the solubility. Acidic soil conditions or an anaerobic soil environment results in increased manganese availability. Therefore deficiencies can be due to alkaline soils, dry weather and high levels of iron, copper and zinc. Like iron, its deficiency is usually due to its unavailability rather than being absent from the soil.

A deficiency is usually expressed again either as a chlorosis similar to iron. However, unlike an iron deficiency, small distinct necrotic spots soon develop on the affected leaves. The initial yellowing also tends to occur some distance from the leaf tip which remains green for some time before the entire leaf discolours.

To rectify a manganese deficiency manganese sulphate can be applied, however, the same limitations apply to it as does trying to rectify an iron deficiency with iron sulphate in alkaline soils. Manganese chelates are also available and therefore recommended on alkaline soils.

Increased levels of manganese have been shown to markedly decrease the incidence of take-all patch. Table 1 illustrates the effects of applying different rates of manganese every four weeks of the growing season to creeping bentgrass grown on a sandy turf soil.

TABLE 1. INCIDENCE OF TAKE-ALL PATCH AT DIFFERENT RATES OF MANGANESE APPLICATION

Manganese added at each application (kg/ha)	Take-all incidence 10 months after first application (%)	Take-all incidence 23 months after first application (%)
0.00	21	19
1.02	15	10
2.04	4	6

Source: Handreck and Black 2002.

COPPER

Copper is involved in many chemical reactions that take place in the plant, as well as the synthesis of certain plant growth promoting substances. Again, deficiencies are seen on highly alkaline soils or heavily leached sandy soils (Beard, 1973). Handreck and Black (2002) also state that high levels of iron, manganese, zinc or phosphorus can lead to copper deficiencies.

Unlike iron and manganese, a copper deficiency will be expressed as a bluish discolouration at the tips of the youngest actively growing leaves. A continued deficiency results in death of the leaf tips and progresses toward the base (Beard, 1973). Overcoming copper deficiencies can be achieved with copper sulphate or copper chelate.

Copper, however, is probably more widely known for causing toxicity problems in turf rather than issues as a result of deficiencies. Beard (1973) states that copper is highly toxic to plants except when it occurs in very dilute soil concentrations. A major cause of copper toxicity is the excessive and repeated use of copper-based fungicides. Copper injury to turf has also been seen when using high rates of copper products in an attempt to kill moss.

Handreck and Black (2002) state that overcoming copper toxicity may be achieved by raising pH, spraying plants with iron chelate solution or adding phosphorus, although a huge excess is difficult to overcome.

ZINC

The most important role of zinc is in the production of plant hormones, especially auxins which promote stem and root elongation. Deficiencies are due to alkaline soil conditions, sandy soils and excessive use of phosphorus.

Due to its role in leaf and root elongation a zinc deficiency can be expressed initially in a stunting of plant growth. The younger leaves are thin and tend to shrivel, while at the same time they darken and become desiccated (Beard, 1973). As with the previous three micronutrients, deficiencies can be overcome by using zinc sulphate or zinc chelate.

CONCLUSION

Soil pH probably has the largest impact on micronutrient availability with the four micronutrients discussed being deficient or unavailable to the plant in alkaline soils, whereas molybdenum, like many of the macronutrients, is far less available in acid soils.

As well as soil pH, sandy soils or those generally with a very low CEC (heavily leachable) are also associated with micronutrient deficiencies. Therefore, testing for micronutrients becomes more important in these situations to ensure a micronutrient deficiency is not the limiting factor to the performance and longevity of the turfgrass.

Skorluski (2003) states that managing micronutrients is not an exact science. Soil and plant tissue tests can help chart the actual amounts within either the soil or plant. However, if there is still doubt whether deficiencies maybe present, a small test plot can always be undertaken. A visual plant response following the application will confirm the deficiency. Table 2 is a guide to application rates of actual amounts of micronutrients discussed in this article that can be used for test plots.

A full list of references for this article can be obtained from the AGCSA on (03) 9548 8600.

TABLE 2. APPLICATION RATES OF MICRONUTRIENTS USED FOR TEST PLOTS

Micronutrient	lb/1000sq.ft	g/100sq.m	Fertiliser source
Iron	0.025	13	Ferrous sulphate (20% Fe)
Manganese	0.025	13	Manganese sulphate (26-28% Mn)
Copper	0.003	1.5	Copper sulphate (25% Cu)
Zinc	0.01	5	Zinc sulphate (35% Zn)

Source: Christians, 2007.