UNDERSTANDING TURF MANAGEMENT
The eleventh in a series by
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TRACE ELEMENTS

Previous discussions in this series of articles have been about the **major elements** required for turf nutrition - nitrogen, phosphorus, and potassium. The concentrations of these elements in the turf tissue are measured in percentage points. Another group of elements essential for turf growth are the **trace elements**. These are elements whose concentrations in the plant tissue are measured in parts per million.

An often used synonymous term - **minor elements** - may result in the belief that these elements are of minor importance which is far from the truth. All of the trace elements are essential for enzyme systems in the grass, however, the amount required to make an enzyme functional is very small, hence the more acceptable term trace elements.

Since the amount required for a specific enzyme function is very small, providing an excessive amount of the same element can often be equally damaging because it may disrupt the function of another enzyme. Therefore great care must be exercise in the use of trace elements. They should never be applied without proper diagnosis, both visual and chemical, and the application rate should be carefully established. The saying "a little may do a lot; a little more may be disaster" is very important to remember in using trace elements.

Those trace elements required for turf production are molybdenum (Mo^-), copper (Cu^{++}), zinc (Zn^{++}), iron (Fe^{++}), manganese (Mn^{++}), and boron (B^-). More recent work has suggested that chloride (Cl^-), cobalt (Co^+) and sodium (Na^+) should be added to the list. From this group iron, manganese, copper and zinc are the elements most likely to be of concern in turf nutrition.

As most soils in Canada are of glacial origin and therefore have a very wide range of minerals contributing to their basic mineralogy, the possibility of a trace element deficiency occurring is rather remote. The vast majority of turf managers in Canada will never see any benefit from the use of trace elements.

Potential Problem Areas

There are situations where the probability of a deficiency must be recognized and taken into consideration if a growth problem occurs. These situations are:

- where there is an acid, sandy soil,
- on a muck soil,
- on an over-limed soil,
- on an excessively fertilized soil,
- where excessive irrigation has been used, and
- poor drainage.

Sandy soils, or more particularly sand based sports fields, are of particular concern due to the very low cation exchange capacity of sands and the low humus content of the root zone. Most of the trace elements are cations, hence are subject to retention and exchange between the exchange complex and the soil solution in the same manner as potassium. With a low exchange capacity loss through leaching becomes a real possibility.

The mineralogy of the sands may also influence the need for trace elements. High carbonate sands originated from materials deposited out of water. The deposition of the limestone rock from water provides a good distribution of all elements. Thus trace elements can be released during the weathering of the carbonate sand grains. Sands derived from igneous rock may be more limited in the distribution of trace elements in the sand grains. Furthermore the rate of weathering of the grains will be much slower.

In a previous article in this series the effect of pH on the solubility of nutrients required for plant growth was discussed. The solubility of most trace elements decreases as the pH rises. Hence one would expect trace elements such as iron, manganese, copper and zinc to become deficient where excessive limestone has been added to a soil or a alkaline sand has been used in construction of a sports field.

Although muck soils are seldom used for sports fields, soils which have been modified by adding excessive amounts of peat or sand rooting zone mixes containing 20% or more organic material may develop trace element problems. Copper deficiency is the condition most likely to occur.

While seldom a problem, excessive fertilization can contribute to trace element deficiencies. For example, excessive phosphorus and manganese have been shown to depress the uptake of iron by grass species.

Mismanagement of water, either through excessive irrigation or lack of drainage, may create conditions favourable to trace element deficiencies. Excessive irrigation contributes to the flow of water through the soil, washing out the elements required for plant growth. On the other hand, reducing conditions created by poor drainage may retard the uptake of iron.

Iron

In the group of trace elements the one most likely to show a deficiency is iron. Iron is essential for normal chlorophyll function and in a number of other enzyme functions. As expected, visual evidence of iron deficiency is a light green colour due to a loss of chlorophyll, particularly between the veins in the newly emerging leaf blade. This inter veinal chlorosis is the identifying characteristic which separates the visual symptoms of iron deficiency from nitrogen deficiency.

Normal bluegrass leaves will contain from 300 to 500 ppm iron on a dry weight basis. Iron is relatively immobile in plants, thus the deficiency symptoms will appear first on the newer leaves. The immobility of iron is aggravated by excessively high phosphorus and manganese in the tissue. Thus plants which, by chemical analysis, are considered adequate in iron, may in fact be deficient, because the iron does not move easily to new growth areas.

Iron deficiency is corrected by the foliar application of 6 kg/ha of ferrous sulphate (reduced iron or $FeSO_4.H_2O$) or a soil application of chelated iron. The material should be applied as soon as mixed if hard water is used because the iron is quickly oxidized and made unavailable to the grass.

A foliar application of ferrous sulphate can create a spectacular change in the colour of turf within a few hours. It can also illustrate the fact that an excessive application can be very detrimental because a doubling of the rate may result in blue-black turf in equally as short a time. Repeated iron applications, especially at high rates, have been known to decrease sod density and rhizome development, resulting in turf which has good colour, but thin.

Deficiency Symptoms

As previously mentioned, iron, manganese, copper and zinc are the most probable trace elements to become deficient in turf grasses. The first step in identifying a problem is the observation of a deficiency symptom. The following are some characteristics to look for:

Iron - chlorotic or light green colour between the veins of younger, actively growing leaves whereas nitrogen deficiency affects the entire leaf and appears first on the older leaves,

Manganese - chlorosis of younger leaves with yellow-green to dead spots on the older leaves and a withering of the leaf tip (Note: nitrogen deficiency can also cause the leaf to die from the tip)

Copper - the entire plant becomes stunted and yellow with abluish appearance to the tips of younger leaves.

Zinc - leaves are reduced in size and grouped together so that the grass has a stunted appearance; leaves may have a darken appearance.

It is evident from this discussion of deficiency symptoms that a clear cut visual diagnosis of a trace element deficiency is difficult. Therefore a suspected deficiency should always be confirmed by plant analysis.

The total concentration of iron in the grass leaf should exceed 50 ppm, manganese should be greater than 15 ppm, zinc greater than 10 ppm and copper greater than 3 ppm.

If the visual symptoms are verified by the chemical analysis the next corrective step is to spray a portion of the affected area with the sulphate form of the element at a rate of one or two kg of material/ha. If this corrects the problem then that trace element, and that trace element only, should be included in the fertilizer to be used on the field.

Fertilizer Materials

Trace element fertilizer materials may be obtained in two forms, as a sulphate salt or as a chelated element. The sulphate salts are all water soluble, therefore they may be applied as a foliar spray. Caution must be exercised, however, in the their use in foliar applications to avoid foliar burn.

Chelation is the formation of a stable organic complex with the trace element, resulting in a form of the element that is less prone to leaching, but may still be absorbed by the turfgrass roots. Chelated forms of trace elements, such as EDTA-Fe, are more expensive, do not give as rapid a response, but have a longer residual response in the soil than the water soluble sulphates. Other forms of chelated organic molecules are being developed to increase the availability of the trace element to grass plants under high pH conditions. Organic matter (humus) in the soil also has the ability to form natural chelates with trace elements, aiding in preventing leaching of the trace elements from the root zone.

CAUTION

In summary, do not use trace element containing fertilizers unless the appropriate evidence is available that they are needed. Even then use only the element shown to be deficient. Applying a shotgun mixture of several trace elements may create more problems than are solved because while one may be necessary, the others in the blast from the gun may disrupt the nutrition of the grass from another aspect.