CORRECTING MICRONUTRIENT DEFICIENCIES IN TURF

Paul E. Rieke

There are 16 different elements usually considered essential for plant growth. Carbon (C), hydrogen (H), and oxygen (O) are generally provided from water and gaseous forms. Nitrogen (N), phosphorus (P), and potassium (K) are important fertilizer nutrients which are covered elsewhere in this program. Calcium (Ca), magnesium (Mg), and sulfur (S) complete the list of macronutrients, or those nutrients needed in larger quantities by plants. The micronutrients are required in smaller quantities but it is just as important that they be present for the plant. These include iron (Fe), manganese (Mn), cooper (Cu), zinc (Zn), boron (B), molybdenum (MO), and often chlorine (Cl) is included. Occasionally, sodium (Na), silicon (Si), and a few others are suggested as providing some benefit for plants, but data are not available to prove their essentiality for plants.

Some typical concentrations of nutrients in Kentucky bluegrass clippings given as averages for the entire growing season which we have found (cooperative study with J. B. Beard) are 4.2% nitrogen, 0.4% phosphorus, 2.5% potassium, 0.4% calcium, 0.2% magnesium, 280 ppm (parts per million) or .028% iron, 44 ppm (.0044%) manganese, 39 ppm (.0039%) zinc, 17 ppm (.0017%) copper, and 8 ppm (.0008%) boron. The micronutrient concentrations are usually listed in parts per million because of the very low percentages present in plant tissue.

Deficiencies of micronutrients are difficult to determine with soil tests. Even clipping analyses are somewhat limiting because of variation of nutrient concentration through the season and because of soil contamination on the leaves (1). Deficiency symptoms for micronutrients have been described (1, 3, 4). Most deficiency symptoms are associated with a yellowing (chlorosis or loss of chlorophyll) of the leaf tissue. But as the slides of micronutrient deficiencies suggested there is much similarity between these symptoms and other stress or injury problems. The slides were provided courtesy of the Milwaukee Sewerage Commission, showing the work of Dr. James Love at the University of Wisconsin.

The chemistry of the micronutrients in the soil is quite complex, making soil tests for these nutrients of questionable practical value. Iron, Manganese, copper, and zinc react rather similarly, however, in that high soil phosphorus levels and high soil pH values cause these nutrients to be less available even though there is usually sufficient in the soil for the plant to use. In addition an iron deficiency may be related to the iron being insoluble in the plant tissue so it cannot be used efficiently. Usually, in Michigan the iron deficiency is associated with bentgrass or Poa annua on greens. These grasses tend to be more sensitive to iron deficiency than bluegrass and red fescue but are not nearly as susceptible as some of the warm season grasses, such as bermudagrass, zoysiagrass, and St. Augustinegrass (5). Many of the greens in Michigan are heavily irrigated with hard water sources which cause the pH to rise well above neutral, and quite often above 7.5. The root systems under greens conditions are usually shorter than under other turf conditions. Regular clipping removal, rooting in the thatch layer, the use of arsenates in Poa annua control programs, and high soil phosphorus tests are also contributing factors in iron deficiencies. Under these conditions the turf is unable to take up sufficient iron and development of deficiencies are common.

Iron deficiency becomes apparent when the turf has been well fertilized and watered and growing conditions are desirable but the turf does not grow well and may be somewhat yellow in color. One is cautioned to look for other problems as well, however, since disease, insect, nematode and chemical injury, or other stress symptoms could show similar symptoms.

Caution is suggested in correction of suspected micronutrient deficiencies. The amount of a given micronutrient needed in fertilizer form is very small. An over-application could cause a toxicity problem very easily (2). Boron is particularly toxic in small quantities (7).

The soil has a tremendous capacity to tie up iron, manganese, copper and zinc, especially if pH and phosphorus are high as already described. Still this capacity could be surpassed, causing an excess in the soil if good sense is not practiced.

Although iron is the most widely limiting on turf in Michigan, zinc, copper, and especially manganese, are frequently deficient on certain soils for some other crop plants. There have not been sufficient reports of responses to these nutrients on turf to suggest that they be applied as fertilizers.

Iron can be applied as ferrous sulfate or as an iron chelate. The sulfate form can be applied as a foliar spray at a rate of 1 to 3 ounces in 3 to 5 gallons of water per 1000 square feet as often as is necessary. This normally will not be required more frequently than once every two weeks. Several different chelate materials are commercially available. Be sure to follow the manufacturer's directions since there is wide variation in concentration and safe application rates for the chelates. Manganese, copper, and zinc can also be applied in the sulfate or chelate forms. If sulfate is being applied suggested rates as foliar sprays would be in the ranges of 1 to 2 pounds manganese, 1/2 to 1 pound copper and 1/4 to 3/4 pound zinc per acre. Soil applications should be somewhat higher than these amounts because of soil fixation. Application rates per 1000 square feet would be appropriately lower (divide by 40).

Micronutrients can also be incorporated (either sulfate or chelate form) into a complete fertilizer as an easy means of applying them uniformly. The concentration should be such that the micronutrient is applied at the appropriate rate with the complete fertilizer and when it is needed.

If micronutrients are mixed with complete fertilizers, Michigan law restricts the guaranteed percentages of each nutrient to specific levels. For example, the minimum amount of each nutrient which may be guaranteed is as follows: iron - 0.1%, manganese - 1.0%, copper - 0.5%, zinc - 0.5% (or 0.125% organic), boron - 0.12%, molybdenum - 0.04%, and, in addition, sulfur - 1.0%.

Micronutrients are also present in many of the "natural fertilizers". Most notable is sewage sludge. According to recent figures provided by Charles Wilson of the Milwaukee Sewerage Commission, their activated sewage sludge, milorganite, contains over 6 percent iron. Manganese, zinc, and copper, as well as sulfur and a few other elements are also present in smaller quantities. The presence of these nutrients in the sludge can increase their concentration in the turfgrass clippings (6). The amount of these elements in sewage sludge will vary between cities depending on the concentration and type of industries which contribute to the sewage.

One of the reasons for the popularity of sewage sludge is its ability to keep the turf green. Part of this response is surely due to the iron applied and that it is applied in a form which is not readily fixed by the soil (natural chelation effect).

An alternative to iron fertilization is reduction of soil pH if pH is too high. When pH is above 7.5 this may be especially helpful. Elemental sulfur can be applied in spring or fall at 10 to 15 pounds per 1000 square fee annually. Soil tests should be used to determine the need for repeat applications. Additional sulfur will usually be necessary but caution is urged since injury can occur if pH is lowered too much. The pH change will begin at the surface so soil pH should be checked annually in the 0-2 inch depth.

Continued use over a period of years of an acidifying fertilizer such as ammonium sulfate (21-0-0) can cause pH to reduce. At the Kensington Park Golf Course Dick Dahn and Jim Smith have observed a drop in Ph from 7.4 to 6.8 in a period of 4 years with ammonium sulfate when applied at a rate of 9 pounds nitrogen per 1000 square feet per year. The acidification rate will depend on the amount of free carbonate in the soil, soil texture, and quality of the irrigation water.

Although a deficiency of boron on turf is not likely to occur in Michigan, should this happen, a foliar application of sodium borate can be made at a rate of not more than one-fourth pound per acre. For molybdenum deficiencies, sodium or ammonium molybdate can be applied at the rate of 2 ounces per acre, also a a foliar treatment.

1. Davis, R. R. 1969. Nutrition and fertilizers. In Turfgrass Science. American Society of Agronomy Monograph 14:130-150. Madison, Wisconsin.

2. Deal, Elwyn, and Ralph E. Engel. 1965. Iron, manganese, boron, and zinc: Effects on growth of Merion Kentucky bluegrass. Agron. Jour. 57:553-555.

3. Larson, R. A., and J. R. Love. 1967. Minor element deficiency symptoms in turfgrasses. Golfdom 41:31-34.

4. Love, J. R. 1962. Mineral deficiency symptoms in turfgrasses. Golfdom 36(9):

5. Madison, John H. 1971. Principles of Turfgrass Culture. VanNostrand Co., New York.

6. Markland, F. E., and Eliot C, Roberts. 1969. Influence of nitrogen fertilizers on Washington creeping bentgrass, Agrostic palustris Huds. I. Growth and mineral composition. Agron. Jour. 61:698-700.

7. Oertli, J. R., O. R. Lunt, and V. B. Youngner. 1961. Boron toxicity in several turfgrass species. Agron. Jour. 53:262-265.