Experimental variety of Kentucky bluegrass (left) is tolerant to low iron availability compared to a common non-tolerant variety (right). Note mottled appearance of grass on right caused by iron deficiency.

Iron For Turfgrass

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TURFGRASS intensively managed and used, such as in golf course operations, requires a well planned fertilizer program to maintain plant vigor througohut the season and from year to year.

Nutrient deficiencies are normally quite simple to correct (or avoid) by means of fertilizer applications. Many fine products are available on today's market that are both effective and easy to use. Iron, however, is a somewhat more difficult problem, especially in the calcareous soils common to much of the western United States.

Soil Iron

Mineral soils contain an abundance of iron. Quantities generally range from 0.5 to 3% of the total soil weight. This is about the equivalent of 400 to 2500 lbs/1000 sq. ft. to a depth of 1 foot. The total content of soil iron, however, does not reflect the iron supplying power of the soil (plant available iron).

Soils having a high pH and high lime content (calcareous soils) are most apt to have a deficiency of plant available iron. This is referred to as "lime-induced" chlorosis and is a common problem in much of the arid west. When soluble iron is added to these soils it is rapidly oxidized from the ferrous (Fe^{2+}) to ferric (Fe^{3+}) form and precipitated as insoluble or very slightly soluble oxides and hydroxides (Figure 1.). Due to these reactions the availability of iron (native compounds and commercial inorganic products) for plant uptake is at a minimum above pH 7.5.

Iron deficiency may be induced or accentuated by heavy phosphorus fertilization. This apparently is due to a physiological antagonism within the plant itself which inactivates a portion of the absorbed iron.

Other conditions which favor iron deficiency include cool temperatures and high soil moisture. In years when we experience cold, wet springs, deficiencies are more prevalent. Over-watering can give the same results. An imbalance of metallic ions, such as high availability of copper or manganese in relation to iron can also induce iron deficiency symptoms. Water containing bicarbonate will tend to raise the pH in the rhizosphere favoring iron precipitation and deficiency.

Iron in Turfgrass

Turfgrass production is a unique form of agriculture. Success is not measured by total production, but rather by appearance. Crop quality — intensity of color — is of paramount concern.

The objective in turfgrass production, therefore, is one of producing chlorophyll. Related to this goal is the genetic ability of the turfgrass itself to produce chlorophyll and any

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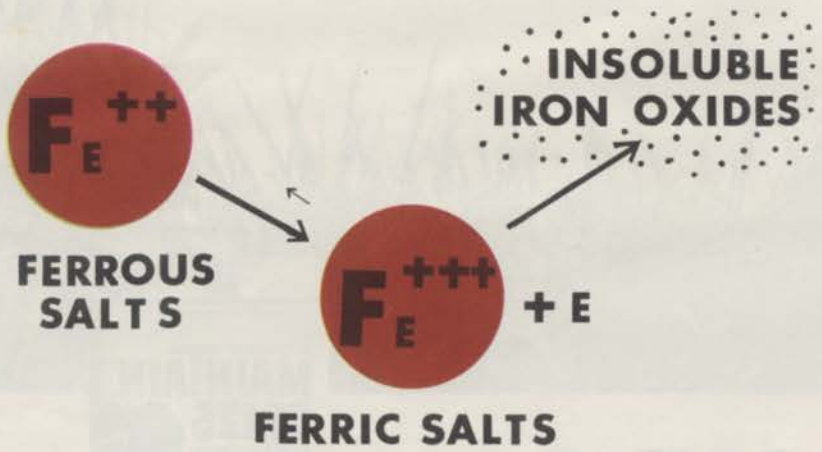

FIGURE 1. Soluble iron is rapidly precipitated when added to calcareous soils.

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environmental factor that affects chlorophyll production. Iron is not a constituent of the chlorophyll molecule (as are nitrogen and magnesium) but is essential in the chlorophyll-producing mechanism.

There is a paucity of information on the role of iron in turfgrass production. However, Pocklington has done an interesting study on the relative abilities of five bentgrass varieties to produce chlorophyll under different growing conditions. He noted that those varieties having the higher chlorophyll contents are the darker green.

Since considerable research has been conducted to select turf varieties with genetic abilities to produce dark green leaves the need for iron by certain varieties may have been significantly increased. Chlorophyll production is, of course, a basic consideration.

Pocklington demonstrated that chlorophyll contents are not constant throughout the growing season but vary in accordance with the available sunlight. Thus the color intensity of grass could be expected to be less in the spring and fall months when net solar radiation is less.

It was further noted that varieties having the less intense green color and chlorophyll content were also lower in iron. However, total iron in each case investigated appeared to be sufficient for normal physiological activity.

Identifying Iron Deficiency

Identifying iron deficiency in turfgrass can be a relatively simple matter. Nitrogen and sulfur deficiencies will both give similar symptoms. However, under a proper fertilizer management program, nitrogen will be adequately supplied on a routine schedule. Sulfur deficiency in the western United States is a rare occurrence. If cases of sulfur deficiency are known to occur in an area, they can easily be verified and corrected through fertilization with various sulfur containing materials.

Iron deficiency will cause the leaf blades to turn lime-green, then yellow, in color. Growth will otherwise appear normal except under acute conditions. The yellowing (chlorosis) will not be uniform over the entire area, but will appear as randomly scattered spots giving a mottled appearance to the area. Such a mottling is typical of a micronutrient deficiency thus aiding in separating iron deficiency from that of nitrogen or sulfur.

Suspected deficiencies can be verified by a soil test. Until recently there was not a satisfactory method to evaluate plant available iron.

The DTPA soil test developed recently by Lindsay and Norvell, Department of Agronomy, Colorado State University, has proven to be a sensitive indicator of available soil iron, and also zinc, manganese, and copper. This procedure has been evaluated mainly with the "traditional" agricultural crops such as, corn, potatoes, etc. However, experience indicates it to be equally effective for turfgrass.

Correcting Iron Deficiency

The reason iron deficiency exists is the same as why it is difficult to correct. That is, an unfavorable soil environment which favors formation of unavailable iron compounds in the soil.

At this time specific recommendations for golf courses and other large scale turf production operations are rather difficult. Little research has been conducted to evaluate the various possibilities based on effectiveness, cost, and compatability with other management practices.

Iron (ferrous) sulfate is the most widely used material today. It is frequently included in the so-called "turf" fertilizer mixes on the market. The extent of its effectiveness will likely depend on the actual amount being applied per unit area and the severity of the deficiency. *As much as 1 lb ferrous sulfate /1000 sq. ft. in a single application may be required per growing season depending on the specific situation.*

Rapid though perhaps short-lived effectiveness may be gained by spraying ferrous sulfate on the turf. Recommendations as to rate of application are quite variable. One reference (Lock and Eck) suggests mixing 1 lb. ferrous sulfate/5 gal. water and applying at the rate of 12½ gal/100 sq. ft. However, another (Younger) suggests 2 oz. ferrous sulfate/1000 sq. ft. These probably represent extremes.

It has been reported by one Colorado State University extension specialist that ½ lb. ferrous sulfate/-1000 sq. ft. applied as a foliar spray will satisfactorily eliminate deficiency symptoms.

Various chelated products are also on the market. One of the most promising for soil application is Sequestrene 138 (FeEDDHA). Experiences in Colorado on turfgrass seem to range from poor to satisfactory results.

The problem we face today in correcting iron deficiency in turfgrass is lack of research information. Both inorganic and chelated products are on the market. However, how these may best be used in your particular operation is very much open to question.

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