Foliar Iron Application on Bentgrass

By Todd T. Fregien

Foliar applications of iron to non-iron-deficient bentgrass are common in the state of Wisconsin. In a 1987 survey, 52 golf course superintendents responded to a questionnaire on the extent of use of iron on turfgrass (Lennert, 1990). Forty-one of the superintendents said they make regular applications of iron and 95% of these are foliar applications. The reasons given for iron applications varied. Better than 85% stated the reason was to enhance the color of turf that was not acceptable due to low nitrogen fertilizer rates. More than one-half used iron for fast greenup before a special event. Other reasons were correction of low soil iron levels and promotion of root growth.

In order to enhance the green color of turfgrass, there has to be sufficient leaf absorption of the iron to induce an increase in chlorophyll content. This is potentially possible because iron is required for chlorophyll synthesis even though it is not a part of the chlorophyll molecule (Mengel and Kirkby, 1987). But this suggestion overlooks a fundamental principal of plant growth. This principal, first proposed in 1862 by Justus von Liebig, essentially states that the rate of plant growth is governed by the level of the most limiting growth factor (Tisdale, et al, 1985). In the case of turfgrass that has poor color due low nitrogen supply, the problem is a restricted protein supply for chlorophyll synthesis. Applying iron under this circumstance simply cannot increase chlorophyll production because it is not the most limiting factor. This explains why Lennert (1990) could not find increases in leaf chlorophyll content when iron was foliarly applied to *Poa annua*, creeping bentgrass or Kentucky bluegrass.

The issue of modification of turfgrass root growth by foliar applications of iron requires a similar examination of the basic processes and principals involved. Turfgrass roots require a supply of carbohydrates from leaves in order to grow. How much carbohydrates the roots receive depends on how much is "left over" after the needs for leaf and shoot growth are satisfied. This, in part, depends on how rapidly carbohydrates are being produced by photosynthesis. When air temperatures drop below about 60 degrees, there is a noticeable decline in leaf growth rate, more carbohydrates become available for root growth and the root:shoot ratio of the turfgrass plant increases (Beard, 1973). From this, we can see that if iron is to increase root growth, it must somehow slow shoot growth or increase carbohydrate production. Lennert (1990) grew creeping bentgrass and Kentucky bluegrass under three different temperature regimes to obtain different shoot growth rates. He then foliarly applied iron and observed the effects on shoot and root growth. What he found was that at optimal and above optimal temperatures for shoot growth, the iron actually reduced root growth. At a mean daily air temperature of 49 degrees, shoot growth was greatly reduced but iron had no effect on root growth. These observations lead to the conclusion that there is little or no experimental evidence that foliar application of iron to non-iron-deficient turfgrass will enhance turfgrass root growth.

That foliar application of iron modifies the appearance of turfgrass is without dispute. The question is, "If there is no increase in leaf chlorophyll content, what is the source of the darker coloration of iron treated turfgrass?". Lennert (1990) used photographs to clearly demonstrate that the color change is due to formation of black coatings, especially on cut leaf tips and areas where leaf tissue had suffered some type of physical damage. Goatly (1994) recently reported the same thing. He found that when he foliarly applied up to 3.75 oz Fe/M in the fall to bermudagrass, there was no greening effect. Rather, the turf was darkened through "staining" of leaf surfaces. The higher the rate of iron applied, the more obvious the staining became.

The purpose of the present study was to verify the observations of Lennert (1990) and Goatly (1994). The site for the study was a stand of nitrogen deficient 'Pencross' creeping bentgrass at the O.J. Noer Turfgrass Research and Education Facility. First the bentgrass was fertilized with 0.4, 0.8, or 1.2 lb N/M to create a range in green color. Once the color response to the N rates was very evident, iron in the form of ferrous sulfate was sprayed on the turfgrass at rates of 1, 2, 3, and 4 oz/M. Darkening of the turfgrass became evident with one-half hour after application of the iron, but at no time was there any visual change in the amount of green color at any of the N rates.

Approximately three weeks after application of the iron, plugs of the bentgrass were collected and taken into the laboratory for examination under a microscope. There were no perceptible changes in the intensity of the green color of the leaves as a result of iron application. Black stained areas were very prominent, especially on mowed leaf tips. Photomicrographs were taken at various magnifications.

Although not nearly as evident in black and white as in color, the contrast between the two photographs in Figure 1 (see next page) do provide a fairly good image of the staining

Fig. 1. Photomicrographs of creeping bentgrass not treated with a foliar application of iron (top) and treated with 4 oz Fe/M (left).

that arose when the creeping bentgrass was treated with 4 oz Fe/M. The higher the rate of iron applied, the more intensive and extensive the amount of staining that occurred.

Figure 2 shows the tip of a leaf under 6x magnification taken from bentgrass treated with 1 oz Fe/M. Note that the black stains are not uniformly distributed over the leaf surface. They are concentrated near the cut tip where bruising of the tissue has occurred as a result of mowing.

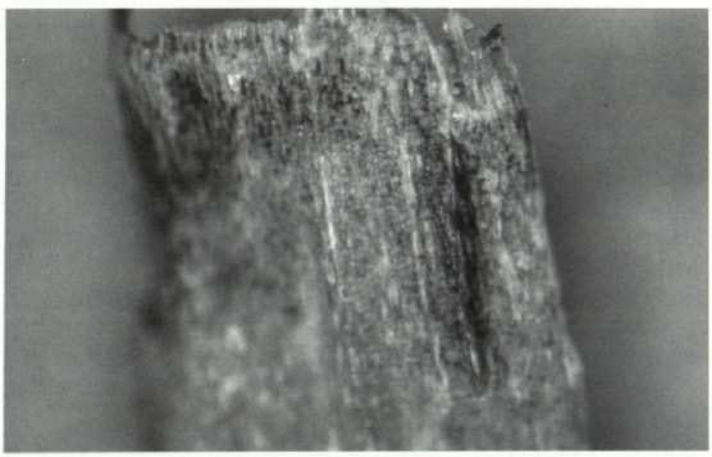

Fig. 2. Photomicrograph of a leaf blade of creeping bentgrass after foliar application of 1 oz Fe/M.

Based on my observations and those of Lennert (1990) and Goatly (1994), it seems rather evident that the primary effect of foliar application of iron on non-Fe-deficient turfgrass is formation of superficial dark stains. This provides a darker background against which the turf is viewed and gives the illusion of a darker green color. Past research (Yust, et al, 1984; Carrow, 1988) has indicated that the black staining caused by even high rates of foliarly applied iron causes no permanent damage to turfgrass. Over time, with successive mowings, the stained leaf tissue is removed and normal coloration returns. This may not always be true. Goatly (1994) found that, contrary to his expectations, iron rates above 0.75 oz/M reduced the levels of total non-structural carbohydrates in bermudagrass in late fall and created the potential for less winter hardiness. He speculated that the reduced levels of total non-structural carbohydrates may have resulted from blockage of sunlight by the iron coatings and reduced photosynthesis.

References Cited

Beard, J.B. 1973. Turfgrass: Science and Culture. Prentis-Hall, Inc. Englewood Cliffs, NJ.

Carrow, R.N., B.J. Johnson and G.W. Landry. 1988. Centipedegrass response to foliar applications of iron and nitrogen. Agron. J. 80:746-750.

Goatly, M. Jr. 1994. Late-season fertilization of bermudagrass turf. Golf Course Management 62(9):60-63.

Lennert, L.L. 1990. The role of iron in turfgrass management in Wisconsin. M.S. Thesis, Dept. of Soil Science, Univ. of Wis.-Madison.

Mengel, K. and E.A. Kirkby. 1987. Principals of Plant Nutrition. Int. Potash Inst., Berne, Switzerland.

Tisdale, S.L., W.L. Nelson and J.D. Beaton. 1985. Soil Fertility and Fertilizers (4th ed). Macmillan Pub. Co., New York, NY.

Yust, A.K., D.J. Wehner and T.W. Fermanian. 1984. Foliar application of nitrogen and iron to Kentucky bluegrass. Agron. J. 76:934-938.

Todd Fregein is a December 1994 graduate of the University of Wisconsin-Madison Turf and Grounds Management Program. The study being reported on here was conducted as a Special Problem under the guidance of Dr. Wayne R. Kussow.