A major irrigation leak could be a problem if you are fertigating at a very high rate. However, small leaks are easily detected due to the presence of fertilizer in the irrigation water. If you have water hazards which receive irrigation water, this could become a problem. Some sprinkler heads may need to be moved or converted to part circle. In most cases, the cost for this should be easily defrayed by fertilizer savings as would any system upgrade to provide uniform coverage. With a double row irrigation system we have found no detectable variation in color or growth due to coverage.

Another potential drawback to fertigation we saw was an increase in fairy rings. This could have been due to nearly ideal climactic conditions. I feel, however, that it may be due to the lower amounts of nitrogen we used. The turfgrass plant is so efficient at absorbing urea through the leaf tissue that I feel very little is reaching the soil.

Mr. Eric Lavold conducted weekly soil tests on our first fairway and first green in 1994 as part of his summer internship for the University of Wisconsin-Madison under Dr. Wayne Kussow. The results show that the nitrogen level in the fairway samples average about 5 ppm and the green samples averaged 3 - 4 ppm. I would consider this too low to support an active microbial population which could keep the fairy rings in check.

At the end of the 1994 season we started to experiment with high carbon soil amendments and fertilizers. We are currently running test plots using whey fermentation products and Toro's bioplex 5-3-2. The more I researched this subject I've found that anything that goes into our livestock is good for your soil. In the spring we will run plots using the above mentioned products plus corn steep liquor, kelp (meal extract and concentrate), solubilized leather and molasses.

Most of these are by-products of the food industry and are used in livestock feed. Hopefully the turf industry can find a way to keep these by-products out of the landfill. My hope is to drastically increase my microbial populations, which should lead to better soil and plant health. My real hope is an elimination of the use of fungicides.

Is fertigation for you? If your irrigation system can maintain reasonably healthy turf in semi-drought conditions, a fertigation system should work for you. If you irrigate regular at a low rate, variations in wind conditions should average out a less than perfect distribution pattern. A fertigation system can save time and money, promote healthier turf and offer environmental friendliness.

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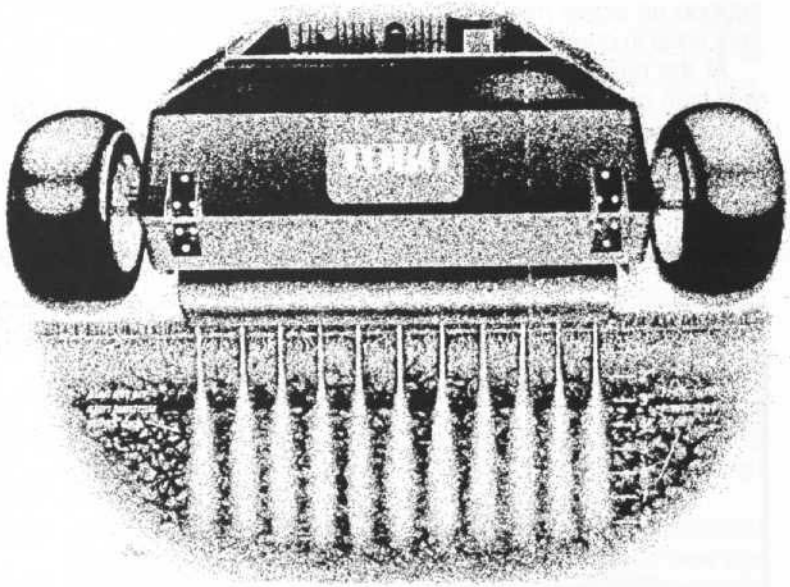

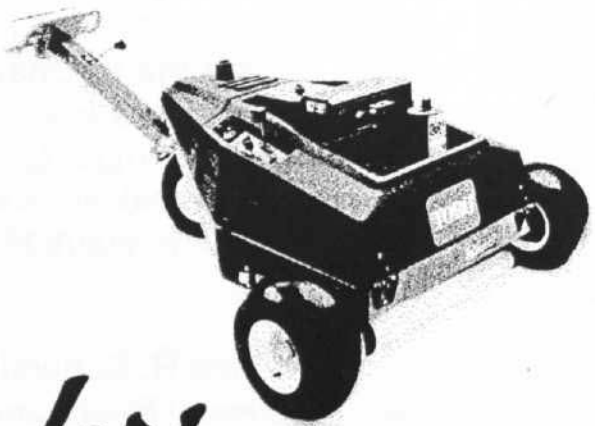

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Foliar Iron Application on Bentgrass

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.

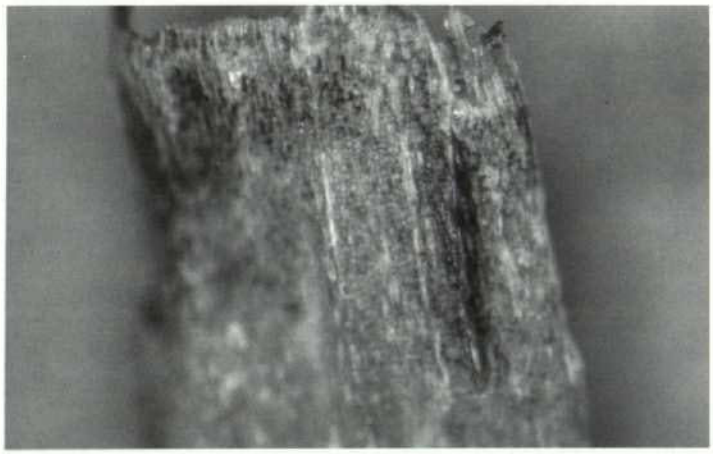

Fig. 2. Photomicrograph of a leaf blade of creeping bentgrass after foliar application of 1 oz Fe/M.

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.

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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.

Another Conference to Attend

By Tom Schwab, Manager
O.J. Noer Turfgrass Research and Education Facility

The winter season sure is the time to sit back and relax from the rigors of summer life. Or is it? It seems the winter is getting so filled up with educational opportunities and meetings that it, too, is becoming more hectic. Granted, most of these conferences are great and really needed if we are to stay on top of all that is new in turfgrass management. But with that has come the demise of a slow season.

As the manager of the Noer Facility, I just gained one more conference to attend. A number of you have asked me who I work for out here. The Noer Facility is one of the 13 University of Wisconsin-Madison Agricultural Research Stations (ARS) spread throughout the state. These stations investigate almost every Wisconsin agricultural product, of which turf and urban agriculture is a big one. In early January we had a week long conference with all 20 of the farm managers and assistant managers of the stations.

This is a group of interesting and sharp individuals. I am the only one who doesn't hold a M.S. degree. There were lots of reports on policies and procedures. We also had a report from one of our managers who just returned from an advisory visit to Czechoslovakia to exchange some of his potato production knowledge. The other managers were encouraged to take short sabbaticals around the world to spread our American agricultural knowledge, also. Some day I may spend some time is West Africa developing some golf turf. My wife spent three and a half years there, in the Peace Corps and doing research on a doctorate degree, and just loved it.

There was another talk that encouraged ARS managers to invite the public out to our farms more often to show what the ARS system is about and to do some positive public relations. I thought the Audubon Cooperative Sanctuary Program (ACSP) that many of you use on your golf courses would be a great tool to help educate the public about the Noer Facility. It exists to study environmentally sound and efficient turf management techniques that provide quality plant life with fewer inputs. Why not tell the public about this?

University of Wisconsin-Madison College of Agricultural and Life Sciences Dean, Roger Wyse, came and talked to us. He had a message on how each research station should become more multi-disciplinary. I took that to mean that the Noer Facility should be investigating more than just turf. Golf courses are growing more than turf, so why not have our research station investigate information on ornamental grasses, prairie establishment, perennials and tree care, also? If we could get funding from these other disciplines and sources, like the Wisconsin nurserymen, commercial greenhouses, landscape contractors and other professional associations, it would help out with the Noer Facility budget.

Lastly, we were presented information on the Worker Protection Standard (WPS) compliance. In the turfgrass business, WPS only pertains to production agriculture like sod farms, but it does include research farms. BINGO! It doesn't include golf courses, athletic fields, parks or lawn care companies. What we have to do at the Noer Facility this year is require that anyone who applies a pesticide must be certified, train everyone working here on pesticide safety, post in a central location notice whenever an application is made (and include specific information on that product), provide decontamination sites and strictly follow any reentry interval stated on the label.

It was great to meet my new Ag Research Station peers at our winter conference. The conference also made me realize my new position is going to be very interesting and challenging. After all, that is what most of these conferences do for us in the winter. They refresh our interest in our professions and give us new challenges and goals to go after.

In closing, I'd like to thank Jennifer Eberhardt for sketching my picture, Monroe Miller for thinking of putting it on the cover of the last GRASS ROOTS, and Frank Rossi for writing such a nice article about me and my family. I couldn't believe I could grace the same cover that has held so many legends in our business. Monroe and Frank both said that I'm going to be more in the limelight now and that people will want to know more about my move to the Noer. I still don't think I am worthy, but it is the highlight of my career.