

Iron and Turf Culture

Bases on an article by Ali Harivandi

Introduction

Success in turfgrass management is measured not by total “matter” production but primarily by appearance. Anything short of a rich, deep green turfgrass may be undesirable. The darkness of turf green is directly related to the chlorophyll content of the shoot; yellowing of turfgrasses reflects reduced chlorophyll content in the leaves. Although genetic makeup of a given turfgrass species or variety plays a major role in chlorophyll production, nutritional deficiencies, especially those of nitrogen (N) and iron (Fe), are usually responsible for lower chlorophyll production.

Turfgrass managers universally recognize the importance of N in a successful management program and apply large quantities of it. The role of iron in turfgrass management, however, is not as widely recognized as that of N and, therefore, Fe is not as widely utilized in turfgrass management.

IDENTIFYING TURFGRASS IRON DEFICIENCY SYMPTOMS

Iron chlorosis in turf appears first in newly developed leaves, which turn light green and then yellow, while older leaves remain green. An entire plant turns yellow from lack of Fe only after a prolonged deficiency. Leaves yellow interveinely with veins remaining green unless the Fe deficiency is very severe or prolonged.

Growth of Fe-deficient turf, despite chlorotic leaves, remains normal.

An available Fe shortage acute enough to produce a bleached, almost white turf produces few morphological changes, with only an occasional necrotic spot at leaf margins or tips. If severe Fe deficiency continues for too long, turfgrass will die. Iron chlorosis is not uniform over an entire area but appears in randomly scattered spots, creating a mottled appearance. This mottling, typical of Fe deficiency, is an aid in distinguishing between Fe and N deficiency, the latter causing uniform yellowing over a large turf area.

Frequent and close mowing of the turf tends to intensify Fe deficiency symptoms. Application of N fertilizers may also intensify the symptoms. Turf species and cultivars vary in their Fe absorption efficiency; thus, at uniform soil Fe contents, some grasses may absorb enough iron to satisfy their needs while others exhibit chlorosis. In most cases, [e.g. Kentucky bluegrass (*Poa pratensis* L.)], however, a soil-available Fe content greater than 20 ppm should be adequate (2). If Fe chlorosis persists in a soil known to contain generally adequate supplies of available Fe, plants can be tissue-tested for chlorophyll and/or Fe.

Table 1 provides leaf Fe and chlorophyll contents for 25 Kentucky bluegrass cultivars and blends grown at soil-available iron of 13.5ppm and pH of 7.3 (7).

The variability in green colour of these grasses illustrates the effect of genetic variability on Fe requirements; the actual numbers may suggest the kind of range within which soil Fe has to be adjusted.

The data from Table 1 suggests that in order to produce an acceptable green colour, Kentucky bluegrass dry shoot tissue should contain more than 177ppm of Fe and/or 2.33 mg/g of chlorophyll. A previous study (12), in which leaf Fe contents were measured in Kentucky bluegrass and

Couch (*Cynodon spp.*) grown in nutrient solutions, concluded that chlorotic leaves can be expected at leaf Fe contents of less than 50-70 ppm.

Although Fe deficiency symptoms may appear throughout the growing season, they usually are most severe late summer to mid autumn. This may be due to discrepancies in soil and air temperatures which results in faster shoot than root growth. In the latter situation it is probable that chlorosis develops because Fe absorption is not sufficient to support the rapidly growing turf shoots.

CAUSES OF TURFGRASS IRON DEFICIENCY

Any one (or a combination of several) of the following may be the cause of Fe deficiency symptoms in turfgrasses:

a. **Deficiency of iron in the soil.** Where soil has been modified as a growing medium (e.g., sand golf and bowling greens and athletic fields, etc.), high leaching and low cation exchange capacity (CEC) may result in Fe deficiency.

b. **Poor root system or weak stand of grass.** A poor root system is not efficient in absorbing Fe, and, if in addition to having a poor root system a turf stand is growing on inherently low available Fe soil or is itself an Fe deficient species/cultivar, it is likely to develop Fe chlorosis. The most common causes of poor root systems are: scalping; excessive removal of thatch; damage by root and crown diseases, root-feeding insects or nematodes; water-logging (over-irrigation or lack of drainage); and compaction.

Table 1. Shoot Iron, Chlorophyll content and Colour Ratings of Kentucky Bluegrass Cultivars and Blends.
(1 = light yellow, 10 = dark green).

Cultivar or blend	Colour rating	Chlorophyll (mg/g)	Total plant Fe (ppm)
Adelphi	10	2.27	271
Ill	10	3.56	296
Sodco	10	3.20	273
Sydsport	10	2.90	266
Windsor	10	2.93	268
Fylking	9	2.88	270
Newport	9	2.62	224
Prato	9	2.75	250
Baron	8	2.53	233
Code 95	8	2.63	224
Common #1	8	2.60	236
Delta	8	2.73	248
Geary	8	2.69	246
Kenblue	8	2.69	262
Pennstar	8	2.54	203
Common #2	7	2.55	226
Melle		2.45	211
Primp		2.42	183
s 21		2.27	202
Merion		2.33	177
Warren's A-20		2.16	172
Park		2.08	198
Arboretum		2.07	164
Nugget		1.53	165
Warren's A-34		1.68	155
Common + Kenblue		3.65	275
Windsor + Merioa		2.72	262
Meriod + Delta		2.31	176
Fylking + Penostar			
+ Nugget		2.17	175
Park + Delta +			
Newport		1.74	171
Mean		2.47	222
L.S.D. (1%level)		1.50	116

c. **Antagonisms from other trace elements.** Elements such as copper (Cu) may compete with Fe for plant absorption thus causing chlorosis in certain soils (8). This need not concern most turf managers since the phenomenon is relatively rare in turf management. However, use of

treated sewage effluent water for turf irrigation or sewage sludge as a soil amendment may lead to Fe chlorosis through competition from other heavy metals.

d. **Excess Nitrogen fertilization.** Heavy N application, particularly when shoot growth rate exceeds that of roots, may induce or accentuate Fe chlorosis. In general, N should never be applied at higher than recommended rates nor be applied during mid to late summer when high temperature may retard turfgrass root growth in favor of excessive shoot growth.

e. **High soil phosphorus content.** Soils containing relatively large quantities of phosphorus (P), either naturally or after heavy P fertilization, are particularly conducive to Fe chlorosis in certain plants, including turfgrasses. It has been suggested that at low soil pH's, P combines with Fe to produce insoluble (i.e., unavailable) iron phosphate (8). At high soil pH, an abundance of soil P may cause P accumulation inside the plant sufficient to inactivate a portion of the absorbed Fe within the plant and thus induce or accentuate chlorosis (1).

f. **Bicarbonate in irrigation water.** More recently, emphasis has been placed on the effect of bicarbonate ion (HCO_3^-) on Fe chlorosis. This is primarily due to the use of reclaimed water for turf irrigation, some of which contains high levels of bicarbonate. By raising the pH of the root zone, the bicarbonate ion may favor Fe precipitation (as iron hydroxide), resulting in Fe deficiency.

g. **High soil pH (“Lime-Induced Chlorosis”).** Iron deficiency in turfgrasses occurs most often in alkaline calcareous soils (lime induced

chlorosis). In general, at soil pH's of 7 and below, Fe availability is favorable to turfgrass. At pH's higher than 7 (typical of calcareous soils), Fe availability declines dramatically and can limit turf health.

h. Turf susceptibility to iron deficiency. Iron chlorosis may affect both cool and warm season turfgrasses. Iron chlorosis has been observed in Kentucky bluegrass, perennial ryegrass (*Lolium perenne L.*), fine fescues (*Festuca spp.*) Bahiagrass (*Paspalum notatum Flugge.*), centipedegrass [*Eremochloa ophiuroides* (Munro.) Hack.], zoysiagrass (*Zoysia spp.*), St. Augustinegrass [*Stenotaphrum secundatum* (Walt.) Kuntze], Creeping bentgrass (*Agrostis palustris Huds.*), annual bluegrass (*Poa annua L.*), tall fescue (*Festuca arundinacea Schreb.*) and couch.

Among the cultivars of each species, a dramatic range of responses to Fe chlorosis may be observed. This range reflects a wide variation in the cultivars' ability to absorb and/or utilize Fe.

CORRECTING TURFGRASS IRON DEFICIENCY CHLOROSIS

Once the cause(s) of Fe chlorosis is determined, one or more of the following practices may be investigated as a remedy:

a. Correct causes of poor root system and weak turf. If Fe chlorosis develops between a pH of 5 and 7, a further examination of the turf root system is appropriate. Short, stubby, dark roots indicate a poor root system that is unable to extract adequate iron or other nutrients. As mentioned above, possible causes of a poor root system include lack of drainage, over irrigation, compaction, disease, insect and nematode damage. Once the cause of weak roots is remedied, Fe deficiency symptoms usually disappear.

b. **Follow a proper nitrogen fertilization program.**

c. **Analyze the soil for phosphorus.** Do not add P unless soil tests call for it. It is also advisable to reduce P fertilization in cases of recurring Fe chlorosis.

d. **Check irrigation water for bicarbonate content.** Where Fe deficiency is a recurring problem, water with high bicarbonate should not be used. If it is not possible to correct the water content, fertilizing with Fe will be essential. Applying elemental sulphur on a regular basis to lower pH and reduce the impact of bicarbonate may be helpful in some cases.

e. **Use iron-efficient turfgrass species / cultivars.**

f. **Reduce pH.** As mentioned earlier, the most widespread cause of Fe deficiency is Fe unavailability to plants with a high soil pH. Often, therefore, a relatively easy way to correct iron deficiency is to lower the soil pH. This is usually accomplished on calcareous soils by application of elemental sulphur. At a pH above 7, sulphur application over a long period may reduce Fe deficiency. However, calcareous soils of arid and semi-arid regions have a high buffering capacity and, therefore, require relatively large quantities of sulphur over an extended period to lower their pH. Whether applied as a spray or in dry form, sulphur must be washed into the soil immediately to prevent shoot burning. It is a good practice to apply it after aeration to assure better infiltration into the soil and thus more rapid effects.

If a rapid correction of Fe deficiency is desired on these soils, fertilizers containing Fe should be applied. An investigation into the use of

sulphuric acid to lower the pH of calcareous soils on which common couch grew [*Cynodon dactylon* (L.) Pers.] demonstrated that this form of sulphur was more effective than either ferrous sulphate or iron chelate (Fe-EDDHA) in correcting Fe chlorosis (13).

g. Apply iron containing fertilizers. Application of Fe containing fertilizers is appropriate where rapid improvement of turf is desired. Several commercial Fe containing materials are available for use on turfgrasses. These include soluble sources (ferrous sulphate, ferrous ammonium sulphate), synthetic chelated carriers (Rexolin Fe DTPA), natural chelated iron from sewage sludge, and mined iron containing minerals.. The amount and kind of Fe needed to correct chlorosis depends on its severity, time of year, whether or not the material will be sprayed on or applied as granular, etc. In addition to fertilizers mentioned here, many regularly available brands of complete turf fertilizers contain various amounts of Fe.