Minor Element Deficiency Symptoms in Turfgrass

By ROGER A. LARSON and JAMES R. LOVE

The foliar deficiency symptoms of the major and minor nutrient elements for many agronomic and horticultural plants have been described and illustrated in the excellent publications listed at the end of this article. However, in none of these investigations was any turfgrass used as the test plant. To remedy this apparent oversight, the O. J. Noer Research Foundation, Inc. has sponsored a mineral nutrition study at the University of Wisconsin. One portion of this work dealing with the nutrient deficiency symptoms of the major elements was reported in GOLFDOM. It is the purpose of this article to report another portion which deals with the deficiency symptoms of the minor or trace nutrient elements: iron, manganese, zinc, molybdenum, boron and copper.

The grasses used in this investigation were Merion and Common Kentucky bluegrass, Common Bermuda and Seaside bentgrass. Each was grown from seed in nutrient solution cultures which had been carefully purified, so that the only source of the minor element in the treatment under study was that contained in the seed. With one exception, this amount was sufficient for all of the grasses to reach maturity before the shortage manifested itself. The single exception was iron. Some of this nutrient had to be added weekly to the no iron treatment in order for the plants to reach maturity, at which time the iron was withheld from this treatment and the deficiency symptoms noted as they appeared. Each treatment was duplicated and each deficiency symptom was reproduced twice to ensure exactness of the method. In all instances the visual symptoms were found to be reproducible.

It is of interest to note that the order of appearance in the deficiency symptoms was the same for each of the grasses studied. The sequence (from first in appearance to the last) was: iron, manganese, zinc, molybdenum, boron and copper. With the exception of molybdenum, which will be discussed later, this is the typical order for the average concentration of the minor elements in grass leaves. Furthermore, as those who have worked with these grasses know, Bermuda has a much greater nutrient requirement than either the bents or bluegrasses and, as such, it was always the first to show deficiency symptoms. In this same vein, it should be emphasized that while Merion is thought by some to be a heavier feeder than the common bluegrass variety, this difference was not manifested in this study, possibly because of the small amounts of minor elements required. No differences were found in either their minor element deficiency symptoms or the order in which they appeared. Also, they were generally slower than the Seaside bentgrass in exhibiting their deficiencies although on this point a difference in content of the trace element in the seed could be an important factor.

Before describing the individual symptoms, it should be emphasized that while chlorine is a minor element, it was not included in this study because it is virtually impossible to exclude it as a contaminant in soil: and, as such, its deficiency will most likely never be seen under field conditions. Lastly, since any description is a matter of individual judgment, the illustrations in the accompanying color plates should be studied carefully and used in making the final diagnosis along with other pertinent information, such as fertilization records, chemical soil tests and leaf tissue analyses.

Iron: The initial symptom of iron deficiency in all of the grasses studied begins as an interveinal chlorosis (yellowing) in the blades of the younger leaves. If allowed to progress, this condition gradually leads to a general paling of the entire leaf area, including the midvein. In the more advanced stages the blades become ivory to nearly white in color and are characterized by the almost complete lack of tissue breakdown or necrosis, in spite of the fact that they are nearly devoid of chlorophyll.

It is an interesting observation that, of the nutrient elements most often lacking in turfgrass, nitrogen (of the majors) and iron (of the minors) should produce deficiency symptoms which are very much alike in appearance and which can easily fool the casual observer. However, a more careful study to determine which part of the plant is affected will generally yield the facts needed to distinguish between the two. For example, nitrogen deficiency always shows itself first in the older parts of the plant, that is, in the tips of the blades of the lowest leaves; while iron signals its deficiency first in the younger plant parts, that is, at the base of the blade of the uppermost leaf.* As the accompanying colored plate of the Bermuda plants shows, nitrogen and iron deficiencies are inverted images of each other.

Manganese: The symptoms are similar for all three grass species and in the initial phase closely resemble iron deficiency. However, following the interveinal chlorosis stage, the manganese deficient plants soon develop small necrotic spots on their leaves. These lesions are not restricted to any particular part of the leaf, although they usually occur in the middle to lower half of the blade. When the diseased area is near the margin of the blade, a characteristic rolling of the leaf along the affected side occurs, causing the blade to bend in the direction of the roll. Manganese deficient grass has a very soft feel, and the bending effect gives it a limp appearance.

Zinc: Stunting is the first evidence of zinc deficiency to appear. In the bent and bluegrass species the starved leaves become uniformly thin, and in the shriveled state they closely resemble a fine fescue. Accompanying this condition, and undoubtedly associated with the drying of the tissue, is the somewhat darker color noted in these grasses. In Common Bermuda only the half near the tip is withered which gives the blade a very pointed appearance. Also, in the case of Bermudagrass, a white crystalline exudate develops that speckles the entire leaf blade, possibly the residue of internal tissue breakdown being exuded through the stomatal openings on the leaf surface.

Molybdenum: As discussed earlier, molybdenum is a mobile plant nutrient. Accordingly, the plant part first affected should be the tip of the lowermost leaf, and an inspection of each of the grasses in this series reveal this to be true. Like nitrogen deficiency, however, a general chlorosis develops prior to the tip involvement; and with the exception of the area just below the chlorotic tip of the blade of Merion bluegrass on the right, this condition can be seen in all of the grasses studied, although not as pronounced as in the case of complete nitrogen starvation. A possible explanation for this lies in the fact that molybdenum is necessary before the plant can utilize the nitrate form of nitrogen; however, any ammonium nitrogen can still be used by the plant in the complete absence of molybdenum. A small amount of ammonium nitrogen was used initially (as part of the phosphate carrier), and, when this was later discontinued, the aforementioned anomaly could not be duplicated again in the Merion bluegrass series. All of the other signs were repeated, however, including the pinched effect at the base of the blade in the advanced stages of molybdenum deficiency in Common Bermuda.

Boron: With the exception of molybdenum, the requirement of turfgrass for boron is usually less than that of any other minor element. Unlike molybdenum, however, which can be translocated from the older to the younger more rapidly absorbing tissues, boron is immobile. As such, its supply to the plant must be renewed from time to time. The fact that Bermudagrass is a very heavy feeder helps explain the reason why it was the only turfgrass in which Boron deficiency symptoms could be elicited, and then only when the plants were allowed to grow unclipped. In the latter condition, each stolon represented, in effect, several culture solutions in series and the leaves at each node helped to lower the concentration of boron in the cellular fluids that were transmitted along the stolon to the terminal nodes. As the plants in the accompanying colored plate show, boron deficiency is characterized by a stunting of the growing points, with the result that the leaves are stubby, the nodes enlarged, and the internodal distances shortened. In effect, the plant assumes the classical rosette appearance. Soon after these symptoms appeared, the leaves developed streaks of an interveinal chlorosis.

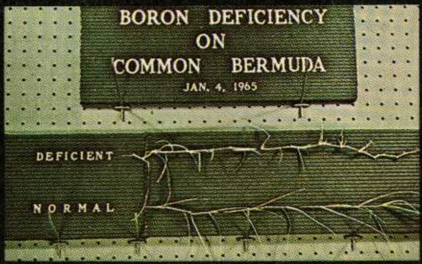
Copper: Symptoms of copper deficiency are not very well defined in the grasses studied. Like zinc, the copper starved plants took on a bluish cast, although in the case of copper, this darkening in color was not accompanied by any noticeable withering of the leaf blades. Also, as in zinc deficiency, no chlorosis was noted which in itself sets these two nutrients

**The reason for these differences is given as follows. Nutrient elements that are able to leave the older parts of the plant and move to the younger or developing tissues when they are needed, are referred to as mobile elements. All major plant nutrients except calcium belong to this group and include nitrogen, phosphorus, potassium, magnesium and sulfur. In addition, two minor elements, molybdenum and chlorine, exhibit this property. All other minor elements, as well as calcium, are incapable of being translocated and are classified as immobile plant nutrient elements.*

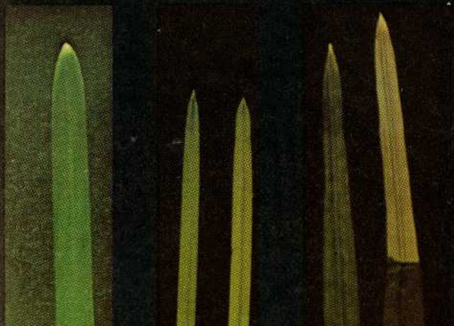
COMMON BERMUDAGRASS

All Elements   No Iron   No Manganese   No Zinc   No Molybdenum   No Boron

No Nitrogen—All Elements—No Iron

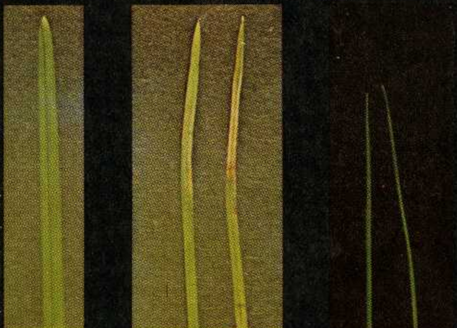


MERION BLUEGRASS



All Elements   No Iron   No Molybdenum

COMMON BLUEGRASS



All Elements   No Manganese   No Zinc

SEASIDE BENTGRASS

All Elements   No Iron   No Manganese   No Zinc   No Molybdenum apart from all the other minor elements. It should be said in passing that in the absence of any other positive identifying feature the question may be raised as to whether copper deficiencies can be recognized, especially in close cut turf.

Editor's comment about practical application.

In the early days of golf turf culture, little thought was given to the minor elements. The reasons were simple. Management practices furnished the needed trace amounts of the minors, thus a deficiency was unheard of.

Soils were newer and better than the lower cost marginal lands now being used in construction. Soils tended to be higher in clay and organic matter content, and thus inherently richer in these vital plant nutrients. They were also better aggregated; with better aeration for better availability of nutrients; and traffic from man and machine was light.

Prior to World War II, frequent topdressing with manure based compost was also commonplace,and an excellent source of the elements discussed in this article. Our, then, lower analysis chemical fertilizers (3-12-4, 5-10-5, etc,) supplied secondary as well as minor elements at a no cost fringe benefit to the customer. Dolomitic limestone used as a conditioner furnished trace amounts of copper, manganese, zinc, boron and iron as well as calcium and magnesium. The phosphorus in the low analysis mixture came from rock phosphate treated with sulfuric acid to furnish sulfur in addition to phosphorus. And, invariably, the mixed fertilizer contained natural organic materials as well as chemicals.

Today, this picture has changed. Putting green soils are high in sand content, and thus easily leached with low retention properties for most plant food elements applied. The conditioners and impurities had to be eliminated from mixed fertilizers to produce the high analysis materials so strongly advocated by some agricultural agencies. In other words, the secondary and minor elements were removed in favor of increased nitrogen, phosphorus and potassium. The words "in favor of" must be used advisedly as grass will not grow on N-P-K alone.

The increased use of irrigation, especially where drainage is poor and traffic is heavy further complicates the minor element problem. Under these conditions, and even though present in adequate amounts, the poor aeration may "tie up" an element so it is temporarily unavailable for growth. This is especially so in the case of iron, and overuse of phosphorus can do the same thing. Thus, the article on Minor Element Deficiency Symptoms in Turfgrass is both timely and important to all progressive golf courses.

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New Mix for Bare Turf Spots

A synthetic soil mix has been developed for patching bare spots in turf, by Dr. Raymond Sheldrake, who is on the staff at Cornell University.

A thin layer of this mix, about one-half inch thick, is spread over the bare spot. Grass seed is sprinkled over this base, covered wth about an eighth-inch of mix and watered. That's all there is to it. No burlap cover is ever needed.

The mix consists of horticultural vermiculite, sphagnum peat moss and a blend of plant nutrients. It weighs about half as much as regular soil, reduces watering time and speeds up the growing time of turf by as much as 30 per cent, according to Dr. Sheldrake.

The mix should prove useful for starting new greens and tees, since weed infestation is minimized by using it.