

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

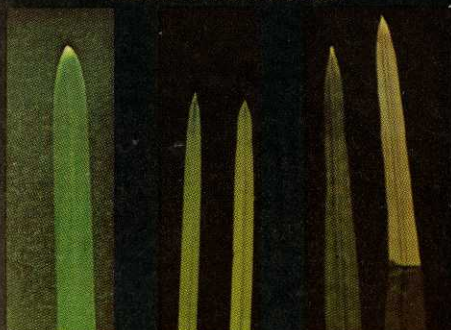
No Boron



No Nitrogen—All Elements—No Iron



MERION BLUEGRASS

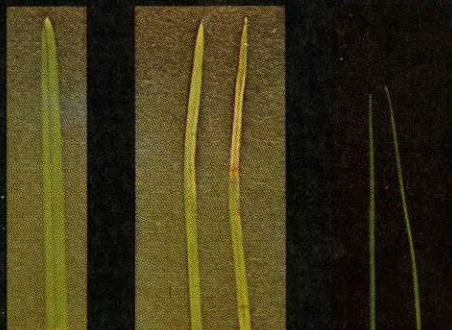


All Elements

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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A Note About The Authors

Mr. Larson is an Agronomy graduate from Iowa State U. He completed the minor element work in partial fulfillment of a Master's Degree in Soils at the U. of Wisconsin. He is now course superintendent at Spyglass Hill.

Dr Love is Associate Professor of Soil at the U. of Wisconsin. Working with the O. J. Noer Foundation's support, he published an article on the deficiency symptoms of primary and secondary nutrients in the September issue of GOLFDOM 1962.

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 with 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.

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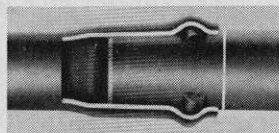
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Many country clubs lease golf cars. As an insurance advisor to clubs, I have had many opportunities to review the lease agreements with respects to the liability insurance which the golf car representative will provide.

In the course of my consulting work, I have become increasingly concerned with the very limited, even disastrous consequences of the insurance provisions.

Let's examine three lease agreements which I have reviewed to determine the reasons for my misgivings. In each agreement, the representative is known as the lessor and the country club as the lessee.

Contract A states: "During the term of this lease, the lessor will maintain liability insurance coverage of \$250,000 for each person and \$500,000 for each accident on golfsters supplied under this lease agreement."

Comment: This lease agreement requires no property damage liability protection nor does it indicate that the country club will be named as an *additional insured* under the policy.

Contract B states: "The public liability policy furnished by the lessor shall stipulate a limit of liability of at least \$100,000 to any one person, and at least \$300,000 to more than one person as the result of any one accident. Property damage liability shall be at least \$5,000."

Comment: Should a golfer be seriously injured or killed, the \$100,000 limit of liability could easily be exhausted by a modern day jury award. Again, the lease agreement failed to name the country club as an *additional insured* in the liability policy.

Contract C states: The lessor agrees to carry, at its own expense, liability insurance on said golf cars, naming both the lessor and lessee as the named insureds."

Comment: This agreement provides that the country club will be named in the liability policy but fails to specify the limits carried. Limits as low as \$10,000 would fulfill this agreement, but would

Is your golf car insurance adequate?

A country club insurance consultant points out that many clubs face financial ruin because of insufficient insurance coverage.

By JOHN F. GLEASON, JR.
Country Club Insurance Consultant

be grossly inadequate should suit be brought following injury or death to a golf car passenger.

Furthermore, none of the lease agreements state the quality of the insurance carrier, leaving the country club with little opportunity to ascertain its financial strength.

Perhaps to the layman the fact that the lessor will provide insurance on leased golf cars appears adequate, but to the trained eye this is not the case.

What value is a liability contract if the interest of the country club is not protected thereunder? Unless the policy provides adequate limits of liability to protect both the representative and the country club in this era when lawsuits are making headlines, the protection is practically useless.

It is more likely that the country club rather than a golf car representative or the manufacturer will be sued. Injured parties are not concerned with ownership. Their cause of action most likely will be against the country club from whom the golf car was rented. Therefore, any country club which leases golf cars must be sure it is named on the lessor's policy or provide liability insurance itself.

Two years ago, a lady golfer in California, who fell from a defective golf car and seriously injured her brain, sued the club where she was a member for \$750,000. Her case was settled for \$200,000.

If the golf car had been leased from a representative under Contract B, the club would have been in real financial trouble. First, the club would have had no legal defense under the lessor's policy. Secondly, in relying on the policy limits, \$100,000 of the judgment would have had to be satisfied by other than insurance company monies. Under Contract C, the settlement would bankrupt many clubs.

There are nearly 100,000 golf cars wending across American fairways daily. With both experienced and inexperienced operators at the tillers, the number of lawsuits which will arise in the years ahead will be staggering.

The need for high limits of liability cannot be over-emphasized. A country club would be far more secure if it would insist upon limits of at least \$500,000 per person and \$100,000 per accident. The prevailing limits which I have seen are inadequate when the cost for higher limits is almost pennies.

If a country club finds that the representative cannot provide high limits, that club should make other arrangements and have the cost deducted from the lease agreement. This may appear arbitrary, but inadequate coverage today is fatal.

Frankly, when the club provides its own insurance on golf cars leased from others, it is in more secure control over the protection provided and the knowledge of the policy's whereabouts.

When insurance is provided by the lessor and a country club is not named as additional insured in the policy, if a judgment is paid by the lessor's insurance company but the negligence was construed to the country club, that insurance carrier may look to the club for reimbursement of the settlement. When the club carries its own liability protection or is named in the lessor's policy, this right of subrogation is denied.

There are two other thorny insurance problems in connection with the use of golf cars. They relate to the responsibility of the player who rents the golf car for a round of golf.

Frequently, country clubs expect the player to hold the club harmless of any suit which arises out of the player's operation of the golf car. Secondly, the club expects the golf car returned in the same condition as it was when rented.

Usually this is accomplished by means of a rental ticket on which the hold harmless conditions are spelled out. While the player's Comprehensive Personal Liability insurance makes provisions for incidental forms of assumed liability, the obligation is not binding upon the company unless the player signs the ticket.

Many country clubs are ignorant on this point. They permit the golf professional

continued on next page

Golf Car Insurance

continued from preceding page

or the starter to sign the member's name to the rental ticket. His insurance carrier need not respond under such an arrangement, nor will one player's company be responsible if his playing partner (not a guest) negligently operates the vehicle.

It is important to have both players who intend to operate the golf car sign the rental ticket if the hold harmless agreement is involved.

One of the leading golf car manufacturers has inadvertently and incorrectly advised in its literature that a player's personal liability insurance will pay any damages caused by the player to the car itself. Regrettably, this manufacturer does not understand the exclusion in the policy which denies coverage on any property rented to the named insured.

It therefore behooves the country club to purchase an Inland Marine Equipment Floater policy to cover direct physical damage to cars which it rents from others. This floater is an "All Risk" contract, responding to nearly every type of loss or damage to golf cars, the principle exception being willful or malicious destruction by the insured.

The policy will protect the club for damages done by others and will also, in the case of leased units, protect the country club's legal-liability, or bailment responsibility, for the property of others within its safekeeping.

When the country club provides the insurance, it is important to have the underwriter remove the right of recovery against any member, guest or employee who negligently operates and damages the golf car. This is a reasonable request as the club is providing this coverage to also overcome the embarrassment to its members who do not have direct damage coverage under their personal liability insurance policies.

Because many golf professionals are independent contractors rather than club employees, it is likewise important to have the policy include the professional

and his staff as named insureds as well. This can be done at no additional premium charge.

In conclusion, it must be concurred that golf car lease agreements and player's rental tickets are tricky legal documents. Unless the club officer who affixes his signature to a lease agreement fully understands the insurance ramifications, he does his country club a grave disservice by executing one.

For that matter, contracts with others should not be signed until they are read jointly by the insurance chairman and the legal counsel who are trained to recognize extenuating problems. ●



About the author — John F. Gleason, Jr., has been in the insurance business for 18 years, since he left Tulane University in his senior year to take over his father's insurance agency.

Four and a half years ago, he founded the Country Club Insurance Service of Cleveland, of which he is director. His function, as he states, "is not to sell clubs insurance, but to advise them on the proper insurance they require on a fee basis."

He is also a writer with more than 50 articles which have appeared in various publications. And, when he finds time, he is an avid golfer with a five handicap.

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Sizing up golfwear

By VINCENT PASTENA

Golf / Golfdom fashion editor

If you're looking for hot, new pro shop merchandise, blazers might fill the bill. Some 1,000 shops in the U.S. already carry blazers and more are taking the initial steps toward establishing blazer sales programs, according to Chuck Cumming, vice president of sales for Charles A. Eaton Co., manufacturer of Etonic shoes and apparel.

Of the more than 7,000 pro shops in the country, Cumming says, 4,500 to 5,000 have the capability to carry official club blazers. "But many pros do not realize the potential sales of this market," he notes.

However, it is obvious that a growing number of pros are rapidly becoming aware of the profit possibilities. Cumming's company alone sold Etonic blazers by Palm Beach to over 800 accounts this year, and the estimates for the coming year are even brighter.

The sales vice president feels that manufacturers' blazer sales could increase 12 to 25 per cent next year, throughout the industry.

William W. Croston, president of Croston & Carr Co., notes that pro shops at 25 per cent of the golf clubs now carry blazers as compared with seven to eight per cent only three years ago.

The company's Croston of Boston, Inc., division sold 5,000 crested club blazers during the period from August 1966 to July 1967—a figure which the company's president feels should double and could even triple next year.

Manufacturers are quick to point out the small initial investment in starting a blazer program. The club blazer is the best launching point. From here, a pro

may see the potential market for a broader line of blazers.

Although resort shops have the bigger market for high-style or fancy blazers (double-breasted, stripes, checks, etc.), several country club pro shops have moved into this area with great success after starting with club blazers.

Etonic suggests an initial order of one dozen crests and one dozen blazers, which should give the pro a good size range. The company will design the crest based on a proposed idea or an already established club crest used on stationery, matchbooks, etc. A drawing is then sent to the club for approval.

A good way for the pro to stimulate interest, Cumming says, is to get the board of directors to wear crested blazers around the club.

The company handles three basic Etonic blazers by Palm Beach in a traditional three-button, patch-pocket style: a Bataya cloth (a blend of Dacron, rayon and cotton), retail \$39.95; a wool flannel, retail \$47.50; and a hopsack of Dacron and wool, retail \$49.95.

The three blazers also are available in two-button models. All come in a wide range of colors.

Of the three fabrics, light-weight Bataya is the most popular because it may be worn the year round in warmer climates and from spring through fall in areas of seasonal change.

Etonic also has added a flannel double-breasted blazer to its line, retail \$55.

An Etonic crest with gold embroidery retails for \$14.95. Of course, this can vary with the elaborateness of the design.

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