Badger Turf and Grounds Club

Boron Deficiency In Putting Greens?

By Forrest D. Dean

***Editor's Note:** Forrest Dean is a May, 1994 graduate of the University. of Wisconsin Turf and Grounds Management Program. His home is Plum Lake, WI, where he acquired his first experience in golf course maintenance. While at the UW and during the summer of 1993, he worked at the Nakoma Golf Club. Forrest is the new Assistant Superintendent at the Old Hickory Golf Club in Beaver Dam. This study was conducted under the direction of his faculty advisor, Dr. Wayne R. Kussow.*

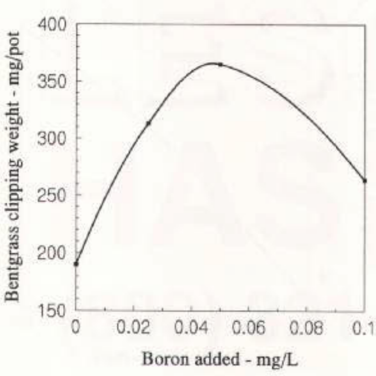
INTRODUCTION

Analyses of clippings removed in October, 1993, from 15 putting greens at the Nakoma Golf Club suggested that the turfgrass from 14 of the greens was boron deficient. According to the interpretative standards developed by Jones (1980), all other essential plant nutrients were within their sufficiency ranges.

This observation came as a surprise, if for no other reason than the fact that no one talks about boron deficiency in turfgrass. Several questions obviously needed to be asked. Are the properties of putting greens conducive to boron deficiency? Was this a unique situation in which the apparent boron deficiency was very transitory? For example, could it be a case in which boron uptake, like that of phosphorus, is greatly reduced when turfgrass growth is slowed due to cold weather (Hall and Miller, 1974)? Did the excessive rainfall in 1993 cause enough leaching loss of boron to induce a temporary deficiency? How reliable are the interpretative standards for boron concentrations in turfgrass clippings?

The purpose of this study was to search the literature for answers to some of the above questions and to verify through experimentation the interpretative standards for boron in creeping bentgrass.

FIGURE 1
Creeping bentgrass growth response to increasing boron supply.



LITERATURE REVIEW

Among the 17 elements considered essential for plant growth, boron is one of the most puzzling from the standpoint of its functions in plants. It has been linked to sugar translocation, protein synthesis, cell wall development, plant reproduction, water balance in plants, and calcium and phosphorus metabolism (Mengel and Kirkby, 1987). Boron is immobile in plants. This is the reason why deficiency symptoms always appear first in the younger plant parts and why severe deficiency results in stunting of the growing points. The deficiency symptoms for turfgrass are initial stunting, enlarged internodes, and a rosetting appearance of individual plants. Formation of streaks of interveinal chlorosis follow (Love, 1964). Clearly, such symptoms would be very difficult to detect in closely mowed turfgrass.

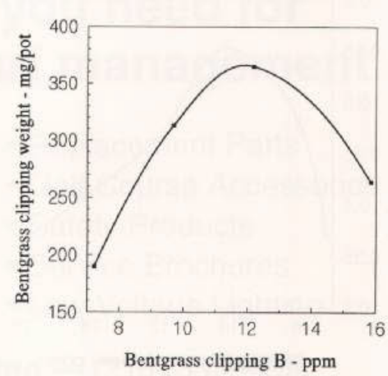
The boron naturally occurring in soil is derived primarily from the mineral tourmaline. Boron deficiency most commonly occurs in crops grown on sandy soils with low organic matter contents. The reason for this is that plant available boron in soil occurs primarily as the boric acid molecule adsorbed on surfaces of clays, iron and aluminum oxides and organic matter. When the boron adsorption capacity of soil is low, the nutrient leaches and deficiencies can result. Deficiencies can also result from high soil pH. When soil pH rises above about 7.0, there is a marked increase in the ability of boron to be strongly adsorbed by organic matter. This can reduce the solution concentration of boron to such low levels that deficiency results. For reasons not fully understood, temporary boron deficiency often occurs during periods of low rainfall and extensive soil drying (Tisdale, et al, 1985).

From this brief literature review, we can see that failure of people to report boron deficiency on turfgrass could be due in part to the fact that it is next to impossible to detect the symptoms in closely mowed turf and on putting greens in particular. It is easy to see where sandy putting green soils may be conducive to boron deficiency. Boron levels are likely to be naturally low unless the sand used during construction or for topdressing contained tourmaline. The new USGA specifications call for 1 to 5 percent organic matter in the rootzone mix (USGA Green Section Staff,1993). Combine low inherent boron content in the sand with ample organic matter and a soil pH at 7.0 or above and the conditions are right for boron deficiency.

EXPERIMENTAL METHODS

The creeping bentgrass cultivar 'Penncross' was grown in solution cul-

FIGURE 2
Relationship between bentgrass clipping boron concentrations and yield.



tures according to the methods of Iyer and Kussow (1985). Once established, the bentgrass was clipped every week at a height of 3/4 inch. Four treatments were used: 0, 0.025, 0.05 and 0.1 mg/L (ppm) boron in 2.5 liters of nutrient solution. The solutions were changed every two weeks.

It was not until after 6 weeks of growth that growth rates at the 0 and 0.1 ppm boron levels appeared to be somewhat less than at the 0.025 and 0.05 ppm boron concentrations. At that time, the pots were clipped and the bentgrass allowed to re-grow for 2 weeks to provide enough tissue for analysis. The bentgrass was then clipped, the clippings dried and weighed, ground, and sent to the State Soil and Plant Analysis for determination of nutrient content.

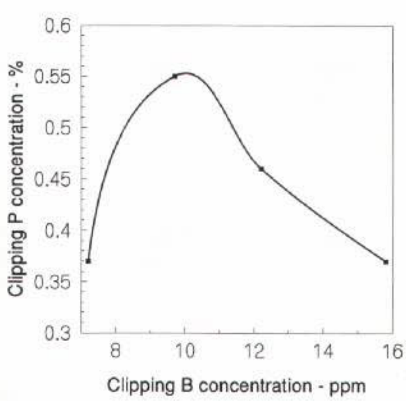
OBSERVATIONS

The only visual signs of nutrient stress were in the 0 boron treatment. In this treatment, the grass blades were very narrow and slightly darker in color than in the pots with boron. No other symptoms were evident

Bentgrass clipping weights revealed optimum growth in the 0.05 ppm boron treatment (Fig. 1). Growth was strongly curtailed in the 0 boron treatment and there was some reduction in growth when 0.1 ppm boron was added.

The relationship between clippings boron concentration and clipping weight was the same as for the relationship between the amount of boron added and clipping weight. Optimum growth occurred at a tissue boron concentration of 12 ppm (Fig. 2). In the 0 boron treatment, where some visual signs of nutrient stress were seen, the clippings contained 7.2 ppm B. Growth was also suppressed at the 0.1 ppm boron level, where the clippings contained 15.8 ppm B.

FIGURE 3
Relationship between bentgrass clipping boron and phosphorus concentrations.



Examination of the clipping analyses revealed that only the tissue concentrations of phosphorus varied substantially from one boron treatment to another. Phosphorus concentrations peaked at a boron concentration of about 12 ppm (Fig. 3). At the highest and lowest boron concentrations, clipping P concentrations were 0.37 percent. While considered sufficient by Jones (1980), these concentrations are at the lower end of the sufficiency range. The reason for this relationship between clipping boron and phosphorus concentrations is unknown, as is its practical significance.

A great deal of care must be taken when applying boron to crops. The quantities generally required are very small, typically in the range of 0.01 to 0.06 lb/M, and over application can result in toxicity (Tisdale, et al, 1985). The reason for this is that plants appear to exert little control over boron uptake. This is apparent in figure 4, where clipping concentration of boron is seen to be directly related to the concentration in the nutrient solution.

CONCLUSIONS

The results of this study support the suggestion that turfgrass that contains less than about 10 ppm B will respond to applications of the nutrient. Jones (1980), based primarily on the research of Oertli, et al (1961), suggests concentrations above 60 ppm as being excessive. The present study indicates that, at least for creeping bentgrass, the upper limit of boron sufficiency could be much lower — somewhere in the range of 15 to 20 ppm. More research is definitely needed to verify these numbers and to examine in greater detail the relationship observed between bentgrass tissue phosphorus and boron concentrations.

Indications are that the turfgrass in 14 of the 15 putting greens sampled at the Nakoma Golf Club were boron deficient when sampled last October. Without knowledge of the effects of cool weather on boron uptake, it seems reasonable to say that at that time of year more than 5 ppm boron in the clippings may have been adequate. Even with this criteria, five of the 15 greens have inadequate boron levels.

Anyone contemplating boron application on putting greens should exercise caution. The range in boron concentrations in clippings between deficiency and excess appears to be very small. Error should be on the safe side; the boron application rate should not exceed about 0.01 lb B/M. This means that the boron carrier has to be blended with another material if applied in a dry form. Perhaps a better approach is to purchase water-soluble 'Solubor' and apply the boron as a carefully calibrated spray that is watered in after application.

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FIGURE 4
Relationship between boron supply and the boron concentration in bentgrass clippings.