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SULFUR DEFICIENCY:
A POTENTIAL PROBLEM
Distribution of total and available
sulfur in selected soils and soil pro-
files. M.A. Tabatabai and J.M.
Bremner. 1972. Agronomy Jour-
nal. 64:40-44. (from the Depart-
ment of Agronomy, Iowa State
University, Ames, Iowa 50010).

The sulfur status of Iowa soils was
evaluated during the course of this
study. Sixty-four surface soils, rep-
resenting the major soil series oc-
curring in Iowa, were analyzed for
sulfate-sulfur and mineralizable
sulfur.

The results indicate that most of
the agriculturally important
soils in Iowa have low reserves of
plant-available sulfur. Thus, these
soils may require sulfur fertiliza-
tion for satisfactory plant
growth, particularly for those
species having a high sulfur re-
quirement. The total sulfur con-
tent of the soils analyzed ranged
from 57 to 618 parts per million; the
average was 294 parts per million.
The sulfate-sulfur content ranged
from one to 26 parts per million and
averaged nine parts per million.
The total sulfur content was high-
ly correlated with the organic
carbon content of the soils. In ad-
dition, the sulfate-sulfur content
was significantly correlated
with the total sulfur content. The
majority of the sulfur occurring
in these soils was in the organic sul-
fur form rather than mineraliz-
able sulfur. Analyses of sulfur
distribution vertically through
the soil profile revealed that the to-
tal sulfur content decreased mark-
edly with an increase in the soil
depth. The authors concluded that
Iowa soils have low reserves of
plant-available sulfur.

Comments: Sulfur (S) is an essential
macro-nutrient for turfgrass growth
and development. A sulfur deficien-
cy results in the disruption of pro-
tein synthesis and a subsequent
impairment of growth. Some sul-
fur also occurs in plant tissues in
the form of sulfates and certain
volatile compounds. The quanti-
ty of sulfur removed in turfgrass
clippings is similar to the quanti-
ty of phosphorus removed.

A sulfur deficiency usually in-
volves an initial paling of the older,
lower turfgrass leaves. The leaf
blades develop a pale yellow-green
appearance as the deficiency
progresses. A faint scorching of the
leaf tip is also associated with dis-
coloration. The scorching ad-
vances toward the base of the blade
in a thin line along each leaf blade
margin. Eventually the scorch-
ing enlarges until the entire leaf
blade is affected and withers.

The visual foliage symptoms of a
sulfur deficiency are quite simi-
lar to those of a nitrogen deficien-
cy. An iron deficiency also ap-
pears as a yellowing and chlorosis
of the leaf tissue; it first appears on
the young, actively growing
leaves. In contrast, the sulfur and
nitrogen deficiencies appear
first on the older, lower leaves. In
this way, one is able to distinguish
between an iron deficiency and
the nitrogen or sulfur deficien-
cies. However, it is difficult to dis-
tinguish between the latter two
other than to make an application
of readily available, water solu-
ble nitrogen to the foliage to de-
termine if there is a greening and
growth response. If not, it would
suggest the possibility of a sul-
fur deficiency, assuming that the
levels of available iron in the soil
are adequate.

As indicated in the above paper, a

continued on page 20
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considerable portion of sulfur in the soils is contained in organic matter and, therefore, is concentrated in the surface horizons of the soil profile. Soils having a lower sulfur content are usually associated with conditions that accentuate the decomposition rate of organic matter and where leaching is more severe. Sulfur that occurs in the soil in the sulfate form is highly water soluble and readily leached.

Sulfur is taken up by the roots as the SO₄⁻ ion. Sulfur can also be absorbed to a limited extent through the foliage as gaseous sulfur dioxide (SO₂).

A significant amount of sulfur can be added to the soil through the absorption and removal of sulfur gases from the atmosphere by rain water. Generally, the quantity of soil sulfur originating from the atmosphere is highest in urban or industrial areas.

In the past, turfgrass fertilization practices have not been concerned with a sulfur deficiency under most conditions. A visual sulfur deficiency was rarely reported. This situation may now be changing to one where sulfur may have to be added comparable to the fertilization practices for nitrogen, phosphorus, potassium and iron.

The reason for this change in the sulfur status of turfgrass soils is that most of the turfgrass fertilizers used in the past have contained significant quantities of sulfur. For example, the nitrogen carrier ammonium sulfate, which was once widely used for turfgrass fertilization, contains 24 per cent sulfur. Similarly, the phosphate carrier, ordinary superphosphate, contains 11.6 per cent sulfur.

Many of the specialty fertilizers now being manufactured for turfgrass use are of higher analyses and contain smaller quantities of sulfur. In addition, the use of ammonium sulfate as a nitrogen carrier source is declining. Consequently, the potential for the development of a sulfur deficiency in certain soils having an inherently low sulfur level has increased. This potential for a deficiency is greatest in those areas continued on page 22.
BEARD from page 20

most distant from urban or industrial locations.

The sulfur content of some common turfgrass fertilizers are summarized in the table. Where the level of available sulfur in the soil is only slightly lowered, the deficiency can frequently be corrected by the regular use of such fertilizer carriers as ammonium sulfate, potassium sulfate, ordinary superphosphate or potassium magnesium sulfate.

Situations may also occur where the sulfur deficiency is more severe. In these cases, materials such as elemental sulfur or gypsum may be used. The elemental form of sulfur normally contains from 85 to 99 per cent sulfur. The rate of sulfur release for plant absorption is dependent on soil microorganisms to oxidize and transform the sulfur into sulfuric acid. This usually requires 10 to 15 days. This process is most rapid if the elemental sulfur is incorporated into the soil prior to turfgrass establishment. Because elemental sulfur has a high foliar burn potential, it is necessary to water it in immediately after application if applied to an established turf.

Gypsum (CaSO₄·2H₂O) is also a source of sulfur that decomposes relatively slowly in the soil. The water solubility is low and thus it is most effective, in terms of a sulfur response, if it is incorporated into the soil. Where a visual foliar sulfur deficiency exists, which must be corrected immediately, it would be preferable to use one of the more readily available, water soluble sulfur sources in the table.

The obvious question to the reader is "do I have a sulfur deficiency?" Just because there have been scattered reports of sulfur deficiencies on turfgrasses around the country does not mean that it is a widespread occurrence at this time, which necessitates an immediate application of sulfur. However, the golf course superintendent should recognize that the potential for the development of a sulfur deficiency is greater under the current turfgrass cultural practices than in the past.

He should be able to recognize the sulfur deficiency symptoms. If adequate levels of both iron and nitrogen have been applied, but the turfgrass response has been inadequate, assuming the soil temperature and moisture levels for growth are adequate, then the possibility of a sulfur deficiency does exist. If this situation occurs, one should first apply sulfur to a small area leaving an adjacent, untreated plot to see if there is any visual response in terms of greener color and an improved shoot growth rate and density. If a positive response occurs and similar responses could be anticipated on the remainder of the turfgrass area, then one may conclude that a sulfur deficiency does exist and steps should be taken to correct the problem.

**Approximate Sulfur Content of Eight Fertilizer Carriers**

<table>
<thead>
<tr>
<th>Sulfur carrier</th>
<th>Approximate sulfur content, %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sulfur, elemental</td>
<td>99</td>
</tr>
<tr>
<td>Ammonium sulfate</td>
<td>24</td>
</tr>
<tr>
<td>Ferrous sulfate</td>
<td>19.8</td>
</tr>
<tr>
<td>Gypsum</td>
<td>18.6</td>
</tr>
<tr>
<td>Potassium magnesium sulfate</td>
<td>17.6</td>
</tr>
<tr>
<td>Potassium sulfate</td>
<td>16</td>
</tr>
<tr>
<td>Ferrous ammonium sulfate</td>
<td>11.6</td>
</tr>
<tr>
<td>Superphosphate, ordinary</td>
<td>11.1</td>
</tr>
</tbody>
</table>

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