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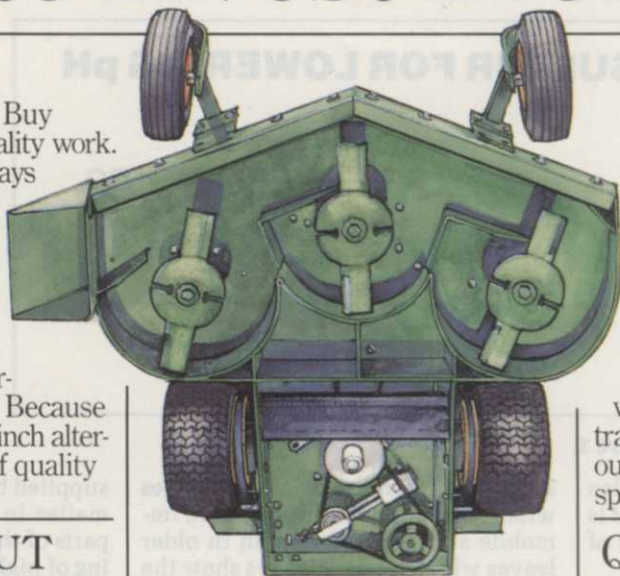
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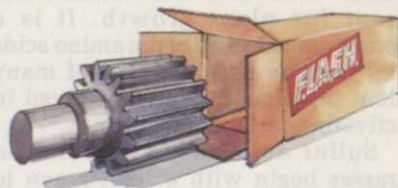
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# THE USE OF SULFUR IN TURFGRASS MANAGEMENT

by Nick Christians, Ph.D., Iowa State University

The amount of sulfur (S) used on turfgrass in the United States appears to have increased considerably in the past five years. This is particularly true on golf courses, but S use also seems to be on the rise on other types of turf areas.

This is fine, providing the S is needed. However, I have recently observed a number of courses where S is being used where it is not needed or where its use is impractical. There are also cases where its use is justified, but it is applied in quantities far in excess of what is required for plant growth.

Elemental S is generally used for three purposes in the turfgrass industry. It is a fertilizer, it can be used as a soil acidifying agent, and it is used in the golf course industry to reduce annual bluegrass (*Poa annua*) infestation.

## Sulfur as a fertilizer

Sulfur is an essential nutrient element for plant growth. It is a constituent of some of the amino acids and thereby becomes part of many plant proteins. It is also involved in activating certain enzymes.

Sulfur deficiency symptoms on grasses begin with a light green to yellow discoloration that can look like nitrogen (N) deficiency. The problem usually becomes apparent when N is applied to overcome the deficiency, and the yellowing intensifies rather than disappears. A close examination of S-deficient plants will usually show the symptoms are worse on newly-emerging leaves and that older leaves are greener.

The chlorosis (yellowing) typical of N deficiency will usually be more intense on older leaves and younger leaves will be greener. This is due to differences in mobility of S and N within the plant.

Nitrogen moves readily through the plant and newly-emerging leaves

## SULFUR FOR LOWERING pH

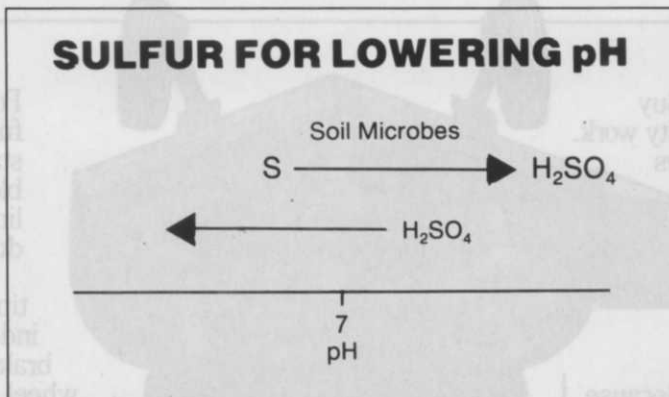


Figure 1.

are given preference over older leaves when N is limited. Sulfur is more immobile and tends to remain in older leaves while younger leaves show the symptoms.

The veins of S-deficient plants are generally yellower than the rest of the plant; however, this is not as easy to see on grasses as it is in plants with larger leaves. Other S deficiency symptoms include slow growth and delayed maturity, but the yellowing will be the most readily visible symptom on the grass plants.

Sulfur deficiency symptoms do occur on turf, but they are rare throughout much of the United States. The reason for this is that S is released into the atmosphere by the burning of high-sulfur coal and is returned to the soil by precipitation. In most parts of the country, this S is sufficient for plant growth. Places exist in the East and Northeast where rain is acidified by the S to such an extent that plants can be damaged by the resulting "acid rain."

Sulfur is also released from the breakdown of organic matter in the soil, and this can be a significant source of S in many areas. The literature is inconsistent as to the S needs of turfgrasses, which would be expected given the diversity of conditions under which turf is managed and the variety of management practices used in its care.

A reasonable estimate for most turfgrasses would be in the range of

8-20 lbs. S/acre/yr. Intensely managed turf grown on sandy soils, with the clippings removed, would require S rates at the high end of the scale.

Notice these figures are in lbs./acre not lbs./1000 sq. ft. Ten lbs. S/acre is the equivalent of 3.7 oz. S/1000 sq. ft., yet it is not unusual for turfgrass managers to apply S at a rate of several pounds/1000 sq. ft.

Remember too that some of this needed S is supplied by the breakdown of organic matter in the soil and that in many parts of the country, S from the burning of high-S coal falls with precipitation. In Iowa, 12 to 15 lbs. S/acre/yr. is derived from precipitation. This combined with the S released from organic matter breakdown supplies more than enough S for plant growth and no S-deficient areas have been identified in the state.

This is true in most states with the exception of those whose precipitation comes from regions where high-S coal is not burned and little S falls in precipitation. These areas include the West Coast states, parts of Florida, and some of the far northern regions of the U.S.

In some geographic areas in the Central U.S., such as the Sand Hills of Nebraska, S deficiencies are found. But in most of the country, S is readily available and no more needs to be applied for the proper management of turf. Information on S needs in a particular area should be available from the local extension service.

If an S deficiency is suspected, soil tests are available to determine if it's needed. However, the simplest way to test for S deficiency is to establish a small test area with an untreated control to prove that there is some benefit from the applied S. *Never indiscriminately treat the entire area until it is certain the application is needed.*

## Sulfur as an acidifier

A soil pH in the range of six to seven



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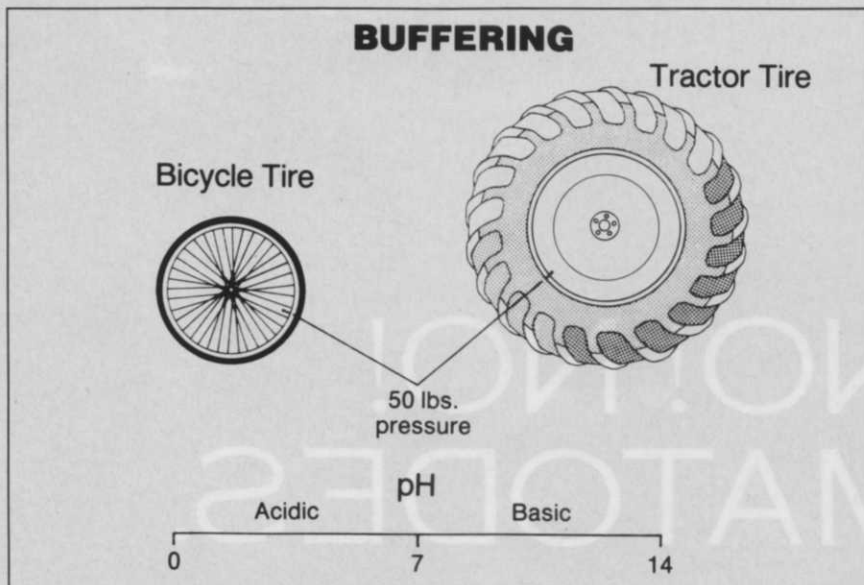


Figure 2.

provides the best chemical environment for the growth of grasses. When pH values fall outside of this range, there are potential problems with nutrient availability and there may be detrimental shifts on microbial populations. If the pH is excessively low, the soil can be limed and the pH raised to the proper level.

Reliable tests are available to determine how much lime is needed in a given situation, and the process of raising pH is relatively easy and inexpensive on most soils. Often the problem is not one of an excessively low pH, but one of excessively high pH. Turfgrass managers throughout the country find pH values of 7.5 to 8.3 (or even higher on the sodic soils of the West) to be common.

The lowering of soil pH (acidification) is generally not as easy as raising pH. Sulfur is the material usually recommended for acidification.

Theoretically, this is a sound practice.

Sulfur applied to the soil is converted to sulfuric acid by soil microbes which lowers pH (Fig. 1). The problem is that in many soils the amount of S required to lower pH is so large that the process is impractical.

The problem soils are the calcareous soils, those that contain lime (calcium carbonate). This is the same lime used to raise the pH of acidic soils. In many soils, calcium carbonate ( $\text{CaCO}_3$ ) is a part of the parent material from which the soil was formed.

Sand-based golf course greens are often formed of sands that contain large amounts of calcium carbonate. Greens containing 5-20 percent  $\text{CaCO}_3$  are not unusual. I have person-

ally tested soil from greens in Ohio that contained up to 40 percent calcium carbonate.

Soil scientists have found that as long as solid lime is present in the soil, it is not possible to decrease the pH. Remember that statement, because it is the key to the decision on whether the use of S will be practical for the lowering of pH.

When S is added to a calcareous soil, sulfuric acid is formed and some of the  $\text{CaCO}_3$  dissolves, but as long as  $\text{CaCO}_3$  remains in the soil the pH cannot be permanently lowered. This resistance to change in pH is known as "buffering." It is very difficult to change the pH of a highly buffered soil, whereas the pH of a soil with a lower buffering capacity can be changed more easily.

An analogy used by soil scientists to explain this phenomenon is to compare pH testing to pressure testing of tires (Fig. 2). Both a bicycle tire and a tractor tire could be measured at 50 lbs. of pressure. When air is released for 10 seconds from both tires, the bicycle tires' pressure will drop several pounds, but the tractor tire will remain very close to 50 lbs. of pressure. The tractor tire is "buffered" against pressure change, but the bicycle tire is not.

The pH of soils is similar. Two soils may both have a pH of 7.5. One may be readily decreased to pH 7.0 by the addition of S, whereas the other, a highly buffered soil with large amounts of  $\text{CaCO}_3$ , could be treated with large amounts of S and show little decrease in pH.

Recently, agronomists at Iowa State University calculated how much sulfuric acid would be required

to dissolve  $\text{CaCO}_3$  in the soil. They determined that if sulfuric acid costing \$1.45 per pound were to be added to a calcareous soil, 68 tons of acid per acre at a cost of \$198,000 would be required to dissolve just one percent of  $\text{CaCO}_3$  in the upper seven inches of soil.

Many turfgrass areas, particularly sand greens, can contain many times this amount of  $\text{CaCO}_3$ . Consider a green that contains 20 percent  $\text{CaCO}_3$  in the upper seven inches of the root zone. This green would contain approximately 10,000 lbs. of  $\text{CaCO}_3$  /1000 sq. ft.

Elemental S can be applied to a bentgrass green at a rate of about 10 lbs. S/1000 sq. ft./yr. Higher rates will usually damage bentgrass.

Many assumptions can be made in calculating how much sulfuric acid will be formed when S is applied to the acid and an exact calculation of how much S would have to be applied to neutralize the  $\text{CaCO}_3$  and to eventually reduce pH are not possible. However, a good estimate would be that 1000-1500 years would be required to dissolve the  $\text{CaCO}_3$  in this green. It is impossible to lower the pH of this area permanently and the use of S in a situation like this is highly impractical.

Temporary decreases in pH in highly buffered soils treated with S are not unusual. However, the detrimental effects of excess S on the turf usually outweigh any benefit from the slight pH decrease.

Another good analogy to explain this phenomenon of temporary pH decrease is that of a coffee pot with a glass stem along its side to show the coffee level in the tank (Fig. 3). When coffee is released, the level in the glass stem drops sharply, but as soon as the flow is stopped it quickly returns to the level in the tank.

Likewise, a highly buffered soil will show a temporary drop in pH when S is applied, but will quickly return to the higher, buffered pH when S applications are stopped.

Situations exist in which the use of S to lower pH may be practical. A soil with pH normally in the range of 6.9 to 7.0 that has been raised by the application of irrigation water high in calcium to a moderately high pH of 7.3 to 7.4, could potentially be lowered by S. However, in most of the cases where S is being applied, the soil is so highly buffered that S has little lasting effect on pH.

To determine if S should be used, start with a pH test. If the pH is 7.0 or below, S is not needed for pH modification. If the pH is high (7.3 to 8.3), lowering the pH may be desirable, but



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is it practical? (Calcium carbonate precipitates in soil at a pH of 8.25 and soil pHs in the range of 8.2 to 8.3 are a good indication that excessive  $\text{CaCO}_3$  may be present).

There is a test to measure the  $\text{CaCO}_3$  content of the soil, although it is not a common test performed by soil testing laboratories. Check with the local extension office concerning the availability of  $\text{CaCO}_3$  tests.

In Iowa, the  $\text{CaCO}_3$  test is available through the Department of Horticulture, Iowa State University, Ames, IA 50011. A private lab in the Midwest that will perform the test is A&L Great Lakes Agriculture Laboratory, Inc., 5011 Decatur Road, Fort Wayne, IN 46806, and there are likely others throughout the country. If the soil contains free  $\text{CaCO}_3$ , trying to lower its pH with S is not advised.

The main concern when the pH is high is that some plant essential nutrients will not be available for uptake by the root system. Rather than trying to lower pH in these calcareous soils, a better approach may be to apply micro-nutrients to the foliage in the liquid form. This approach will not always be practical either, but on high-maintenance areas such as golf

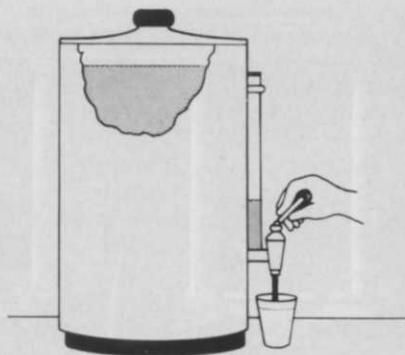


Figure 3.

course greens it would be preferable to trying to lower pH with S.

#### Sulfur for poa reduction

*Poa annua* is one of the most troublesome weed problems on golf courses. No completely effective herbicide has been found to control it. In the early 1970s, research was conducted in Washington state that indicated S could reduce the *Poa annua* population in turf areas. The observations were accurate, but they applied to only one type of *Poa annua* at one

location. The use of S for this purpose has been widely adopted in many parts of the country with mixed results.

Some superintendents report excellent control, whereas others report no reduction of *Poa annua*.

The best approach if S applications are being considered for this purpose is to try it on a limited test area first. It may work, and it may not, but before spending a significant part of the budget on S, be sure its use is going to be effective.

#### Summary

A sound recommendation for the use of S on turfgrass areas can be simply summarized as follows:

1. If S is needed, use it.
2. If it is not needed, don't use it.

In certain situations its use is quite appropriate, but S is also being used in many situations where it is either not needed or its use is impractical. Knowing the difference is an important part of professional turfgrass management.

LM

*Acknowledgment: The author would like to acknowledge Jane Lenahan for preparation of figures 2 and 3.*



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Bare Soil	Weed Arrest	Bare Soil	Weed Arrest	Bare Soil	Weed Arrest	Bare Soil	Weed Arrest	Bare Soil	Weed Arrest	Bare Soil	Weed Arrest
PLANTING RATE											
4 grams per 20 sq. ft.		11 grams per 20 sq. ft.		12 nutlets per sq. ft.		10 bulblets per sq. ft.		9.25 grams per 20 sq. ft.		6.40 grams per 20 sq. ft.	

Percents refer to the percentage of area covered by weeds.

†0.25% means 1/4 of 1%

Pigweed		Bahigrass		Sandbur		Johnsongrass		Purplevetch		Lambsquarter	
50%	0%	51.25%	2%	15%	0%	81.25%	0%	53.75%	0%	41.25%	1.5%
Bare Soil	Weed Arrest	Bare Soil	Weed Arrest	Bare Soil	Weed Arrest	Bare Soil	Weed Arrest	Bare Soil	Weed Arrest	Bare Soil	Weed Arrest
PLANTING RATE											
3.25 grams per 20 sq. ft.		6.90 grams per 20 sq. ft.		10 burs per sq. ft.		4.40 grams per 20 sq. ft.		15 seeds per sq. ft.		5.80 grams per 20 sq. ft.	

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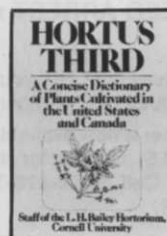
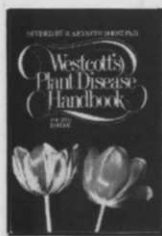
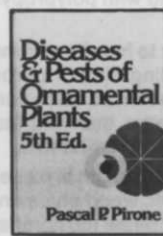
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